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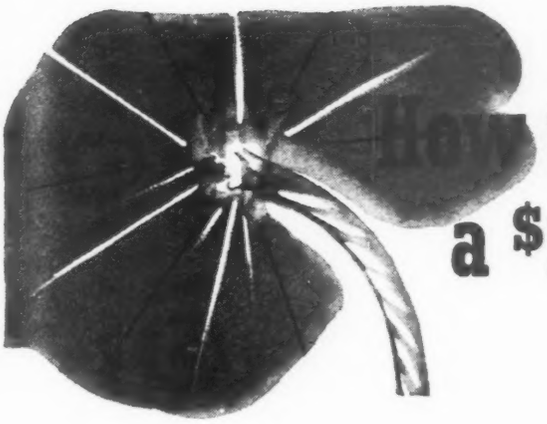

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The Course of Oil

By the Editors

TIDELANDS OWNERSHIP

There has been some disagreement over including discussion of oil deposits in the Supreme Court case concerning title of California tidelands.

Former Secretary Ickes based his arguments for federal ownership entirely upon the right of the federal government to control specific valuable oil off the California coast. Attorneys of the 45 states that joined California in defending the titles to marginal waters insisted on denying the claim only on the basis of federal government versus states rights.

There is no reason why the claim of the federal government cannot be answered on both counts if we keep in mind that oil control is subordinate to the general thesis of states rights. There are many practical reasons why tidelands oil will be developed with greater efficiency under present state control and the people of the United States are best served and protected by domestic oil development.

Secretary of Interior Krug has stated that he hopes the persons now holding leases from states and municipalities to the tidelands minerals would be protected even if the Supreme Court decides the title is in the United States. This is a reasonable statement and appreciated by the industry as such. One of the problems of federal lease holders, however, is the amount of power invested in the Secretary of Interior by the contracts. The regulations are detailed but are so worded that in final analysis they rest on the judgment and decision of the Secretary. Krug may be kindly disposed toward lease holders and work with them effectively, another Secretary may not.

For this and other reasons the oil industry in general is willing to pay higher royalties, on the average, for state leases than to take on federal contracts. The decision of the Supreme Court is important to the country not only because of states rights. It is important for the effect it will have on development of oil in the tidelands.—E.A.

OIL OPERATIONS TAKE TIME

The commonly accepted idea that discovery and development of oil resources are accomplished rapidly and that production is short lived is far from reality and the impression should be corrected. Even those in one phase of the industry often do not understand the extent of time, knowledge, and experience required in divisions outside their own.

Oil production and reserves have not been steadily and substantially increased over a period of 87 years with boom-and-bust fields. Major fields all over the United States are in a continuous stage of development, regardless of how old they are, and some in the eastern states are almost as old as the industry itself. We must remember, too, that there is more oil left in our fields than has been recovered. Some of this production is still recoverable by primary methods, some by secondary methods, the rest must await technological advances.

In terms of wells there have been 818,752 oil wells drilled in the United States since the 1859 Drake well. Of these 423,948 wells, or more than half, are still producing.

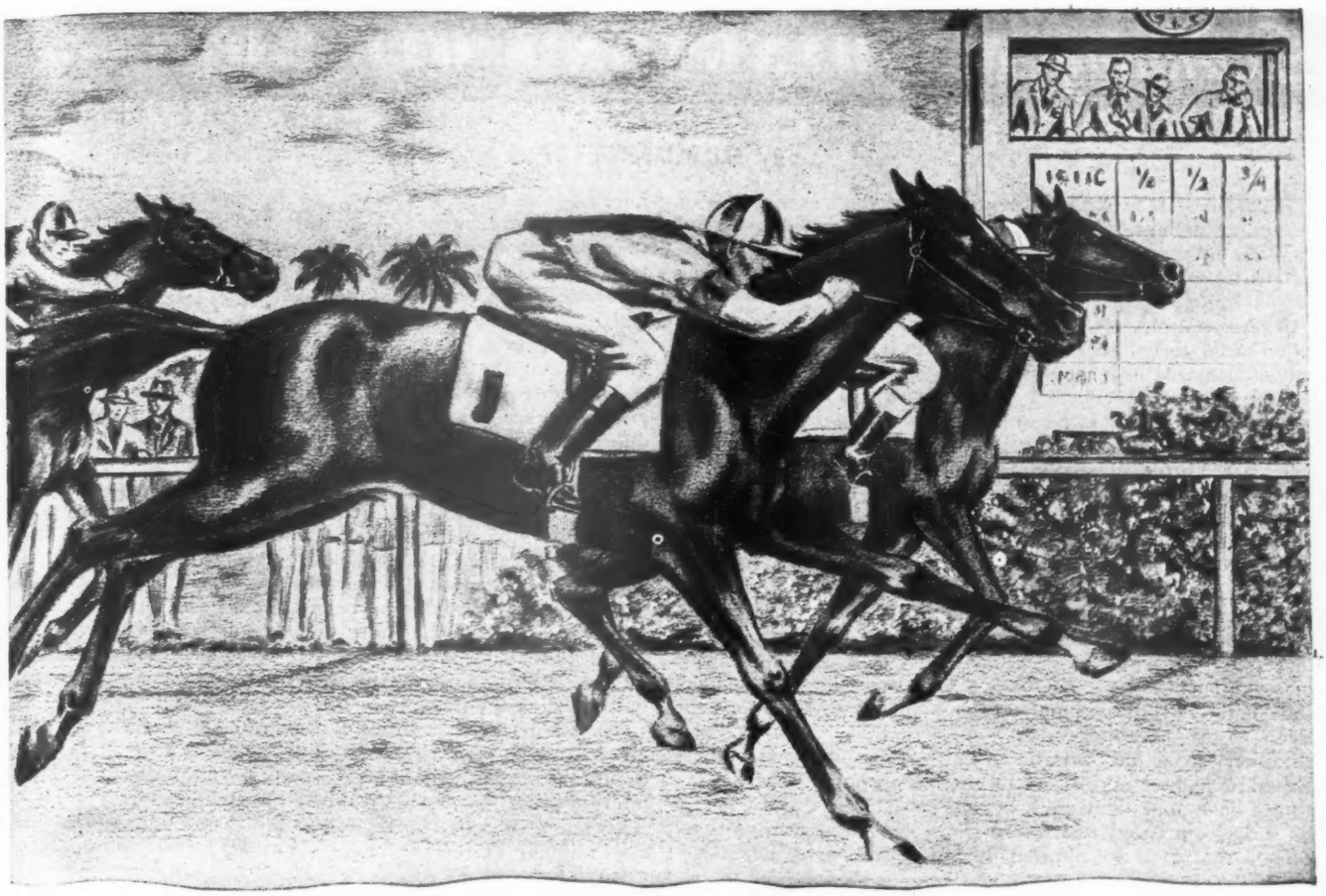
The industry must first realize and then persuade others of the continuity of oil development, the cumulative legacy of learning and experience by oil operators, and the longevity of oil fields. There would then be greater understanding when the formation of public opinion is concerned with development of oil resources as it is in the tidelands title case.—E.A.

UNITED STATES PIPE LINES

Since the first leaky wooden pipe line was laid in Pennsylvania prior to the Civil War, the pipe line industry has enjoyed a steady growth. By the end of 1946 throughout the United States there will be approximately 177,750 miles of trunk pipe lines in service. This figure is for crude oil lines, gas lines, and product lines and, it will be observed, includes truck lines only. Gathering and distribution lines would add many thousands of miles to the total.

To those who are of a statistical turn of mind a breakdown of the figures may be of interest. Of the 177,750 miles, 90,000 miles represents natural gas lines, 72,100 miles crude oil lines, and 15,650 miles products lines. Figures are based on data from the Office of Defense Transportation, Petroleum Administration for War, the American Petroleum Institute, and the late figures, i.e., those for 1946, on reports of work completed and that under construction.

It is a rather odd fact that, with such a vast network, there is no pipe line connecting the West Coast and Mid-Continent. The laying of a line from the West Texas Permian Basin to the West Coast has been proposed, but is still in the uncertain stage. Within recent months the Federal Power Commission has given permission for construction of a gas line from West Texas and New Mexico fields to California, which is expected to result in the conservation of gas that otherwise would be wasted. West Texas, likewise, has the crude oil resources for operation of a line laid from that area to the West. So great is the potential production of crude in that area that existing lines are inadequate. Many wells are shut in; others have their flow restricted sharply.—F.H.L.



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Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Talk of importing more oil as a means of conserving domestic reserves is soft-pedalled now—but the refrain continues in top official circles, especially among military authorities who fear that we are not prepared to fuel another war on United States resources, alone.

Government officials learned their lesson from the violent reaction to the recent radio broadcast on foreign oil policy, which was participated in by representatives of the State Department and the military.

No official is likely to be so brash again as was John Loftus, chief of the State Department's petroleum organization, in that broadcast. Loftus suggested a world oil control organization, implied that some foreign concessions might need overhauling and predicted we would be importing half of our petroleum requirements within 20 years.

The oil shortage predictions got front-page publicity, as always. Oil men were infuriated, but their denials and rebuttal promising plenty of oil didn't get quite the same play in the newspapers. Loftus soon after departed for the Paris Peace Conference on a non-oil assignment that may keep him away for several months. (It has been a long time since one official made both the international oil companies and domestic producers so mad, simultaneously.)

Loftus left behind, however, a network of interagency committees he had set up to work on foreign oil policy. These committees have done their work behind closed doors. But enough has leaked out about their discussions and tentative reports to indicate that they are approaching the question of increasing imports from the angle that this will "conserve" reserves here.

Interior Department had sought—unsuccessfully—to have these interagency oil groups disband on the grounds that Interior, under President Truman's letter to Interior Secretary Krug on May 3, was to be the hub of government oil and gas activities, not State or the Army or Navy.

Krug, himself, recently told the Interstate Oil Compact Commission that the industry "must soon accommodate its thinking to the need for substantial petroleum imports." (With imports now heading for an all-time record high this year, producers are wondering what volume Krug had in mind when he used the word "substantial.")

Most important, however, is the military's attitude. They instigated the State Department's broadcast "hoping it would help to wake up the public." No matter how much oil men may disagree with them, the effect and weight given to the military's views in development of a national oil policy should not be underestimated. It is difficult, though, for oil men to reconcile the military's advocacy of a strong domestic industry with their urging of increased imports. Producers feel that a large volume of imports will discourage exploration and development, ultimately weakening the home industry.

The whole matter may be threshed out, if the State Department agrees to call a conference on imports, inviting domestic producers, importing companies, military authorities and other interested parties, as suggested by the Independent Petroleum Association of America. If State doesn't come through on this, the National Petroleum Council may be asked to sponsor it.

● **AVGAS PLANTS.** Top officials of War Assets Administration are putting on the heat to get rid of the government-owned 100-octane plants. Octane ceilings imposed because of the tetraethyl lead shortage have lessened the incentive to acquire a "cat" cracker. To offset this, WAA would like to have the Civilian Production Agency order use of catalytic cracking as a lead-saver. WAA can be expected to decide soon on which plants are saleable for use in place, push them and let the others be sold for dismantling. Until WAA does something definite, however, most wartime operators of the plants who are using them now are apparently content with their month-to-month leases.

● **STRIPPER WELLS.** Stripper well operators who favor a permanent price differential for their marginal wells would like to hang on to some remnant of the wartime subsidy until Congress has a chance to take up the matter. But Economic Stabilizer Steelman's decision that the subsidy should be reduced to the extent of any increases in crude price postings left the door open for complete elimination of the premium payment plan long before Congress meets in January. If crude price advances wipe out the present subsidy, Congress would have to take up the question anew.

Meanwhile, OPA's oil price staff has been reduced to just one or two officials. Nevertheless, OPA Chief Porter has ordered that oil price trends be watched carefully. To restore oil price controls, however, OPA must get permission from the new Price Decontrol Board. And before the Board acts, it must find that an oil shortage exists, which would be difficult to prove.

● **WEST COAST LINE.** Military authorities have become much interested in the abvisability—from a national defense standpoint—of having a pipe line to the West Coast to supplement California's dwindling reserves in event of another war. Their interest was aroused by the determined efforts of L. M. Glasco, Dallas, to win the military's support for his proposal to dig up the Little Big Inch and relay it as a crude oil carrier from West Texas to California. The military would be reluctant to advise tearing up the Little Big Inch but they might be willing to seek high priority rating for pipe to build a line to California. When they come to consider routes, a line from Rangely field to San Francisco Bay may get consideration.

● **BIG INCH.** War Assets Administrator Littlejohn is somewhat diffident about assuming responsibility for a decision on the Big Inch pipe lines. So he is calling in other departments for their views on the bids submitted. WAA's policy, however, is set on favoring oil use. J. M. Williams, who was vice president in charge of operations for War Emergency Pipe Lines, Inc., took a leave of absence from Atlantic Refining Company to line up prospective shippers for Big Inch, Inc., leading contender among the bidders. If B-I O gets the lines, Williams may become president of B-I-O. More and more there are signs that a number of the major oil companies have accepted the fact that the lines will be used for oil.

● **ROYALTY OIL.** Small refiners without an adequate crude supply will get preference in the sale of public lands royalty oil under the new O'Mahoney Law—but only their present capacity will be counted, nothing will be allowed for expansion or new plants. They will be prohibited from reselling the royalty oil but this will not bar exchanges of crude for crude on a volume or equivalent value basis.

● **WORLD CONFAB.** The idea of a world conference on conservation of natural resources including petroleum, originated with Gifford Pinchot who "sold" it to President Roosevelt. After FDR's death, Harold Ickes sold the idea to President Truman but after Ickes' departure from the Cabinet some reselling was required. Now, it is hoped to hold the conference in this country late in 1947. Truman's letter to U. S. Representative Winant on the United Nations Economic and Social Council laid great stress on the depletion of reserves during the war and heavy demands for postwar rehabilitation.

● **PIPE LINES.** Interstate Commerce Commission is having one of its periodic flashes of interest in pipe lines. Nothing may come of it. On the other hand, if some ICC members have their way Congress will be asked for legislation making all pipe lines common carriers and giving ICC authority to compel connections and extensions. Others favor a reopening of ICC Docket 26570, the pipe line case that has been dragging on since 1934. Another idea is to have ICC, on its own motion, make a study of the common carrier aspect of every pipe line as was planned in 1941 (order was never issued because of Pearl Harbor.)

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NATIONAL PETROLEUM SITUATION

By **H. J. STRUTH,*** *Petroleum Economist*

PRODUCTION CUT-BACK. It is apparent that an immediate cut-back in national crude oil production of at least 240,000 bbl. daily is necessary to prevent accumulation of excessive stocks. Crude oil demand in the last 4 months of this year is expected to average about 4,620,000 bbl. daily. Production in August was at the rate of about 4,863,000 bbl. daily. Inventories have already passed the maximum required working levels and unless production schedules are reduced the industry's stock position will become top-heavy.

LOWER REFINING SCHEDULES. Refining operations will necessarily have to be reduced over the balance of this year. Projected requirements for refined products from September through December call for daily average refinery runs of about 4,630,000 bbl. Estimated runs in August were about 4,887,000 bbl. daily, which means a reduction over the balance of this year of about 257,000 bbl. daily from the August rate. Cumulative figures show that still runs in the first 8 months of this year averaged 4,742,000 bbl. daily, which was about 1 per cent above actual requirements.

STOCKS EXCESSIVE. Combined stocks of crude and refined products at the end of August exceeded maximum working levels required to the extent of more than 1,000,000 bbl. Crude oil stocks increased during August to the extent of about 3,200,000 bbl., while stocks of all refined products rose about 4,535,000 bbl. Crude oil stocks are now about 4,500,000 bbl. above working requirements, while refined inventories are rapidly approaching maximum working levels. Efforts to build up fuel oil stocks have resulted in inventory accumulations since February of 44,471,000 bbl. Fuel oil stocks now represent 58 days' supply, against 25 days' supply on March 1. Stocks are 21 per cent more than a year ago.

DRILLING TREND UP. Higher crude prices are beginning to show their effect in the drilling picture. New operations at the close of August increased 100 over July, while wildcat completions rose from 369 in July to 406 in August. Cumulative well completions through August are about 6 per cent above last year, while new oil well completions are 8 per cent above a year ago. Although the industry drilled 30,000 wells a year before the war, early post-war conditions offered no hope of realizing that rate this year. The expected delay in higher crude prices and continued shortage of materials dictated a normal quota for 1946 of about 27,375 wells. To date, the industry has completed 18,750 wells, against a cumulative quota of 18,225, or about 3 per cent above expectancy. Completions for 1946 may total 28,000.

*Editor, THE PETROLEUM DATA BOOK

Comparative Statistics, August, 1946

*All figures are computed on a Bureau of Mines' Basis**

	Aug. 1946(p)	July 1946(p)	Aug. 1945	This year to date	Last year to date	Per cent change
Wells drilling	3,750	3,650	4,100	3,750	4,100	— 9
Total wells drilled	2,476	2,508	2,346	18,750	17,659	+ 6
Development wells	2,070	2,139	2,007	16,042	14,949	+ 7
Oil	1,276	1,280	1,219	9,899	9,149	+ 8
Gas	246	288	213	1,791	1,630	+10
Dry	548	571	575	4,352	4,170	+ 4
Per cent dry	26.5	27.1	28.6	27.1	27.9	— 0.8
Wildcat wells	406	369	339	2,708	2,710	0
Oil	65	37	35	381	358	+ 6
Gas	13	11	15	80	94	—15
Dry	328	321	289	2,247	2,258	0
Per cent dry	80.7	87.0	85.3	83.0	83.3	— 0.3
Crude production	150,750	153,475	150,965	1,152,687	1,172,373	— 2
Daily average	4,863	4,951	4,870	4,744	4,825	
Crude demand‡	155,050	160,735	165,208	1,207,941	1,225,714	— 1
Daily average	5,002	5,185	5,329	4,971	5,044	
Crude stocks	229,650	226,450	219,956	229,650	219,956	+ 4
Days supply	46	44	41	46	41	
Natural gasoline production	9,870	9,850	9,411	75,938	75,053	+ 1
Daily average	318	318	304	313	309	
Motor fuel production	68,080	65,700	72,318	502,128	545,447	— 8
Daily average	2,196	2,119	2,333	2,066	2,245	
Gasoline yield, per cent	39.5	38.0	42.0	38.2	40.7	— 2.5
Motor fuel demand‡	70,210	67,900	73,000	510,875	546,674	— 7
Daily average	2,265	2,190	2,355	2,102	2,250	
Motor fuel stocks	85,470	87,600	78,318	85,470	78,318	+ 9
Days supply	38	40	33	38	33	
Fuel oil production	60,620	61,200	62,940	488,526	492,182	— 1
Daily average	1,955	1,974	2,030	2,010	2,025	
Fuel oil demand‡	54,430	53,850	58,585	499,897	539,942	— 7
Daily average	1,756	1,737	1,890	2,057	2,222	
Fuel oil stocks	100,990	91,100	83,472	100,990	83,472	+21
Days supply	58	52	44	58	44	
Refinery still runs	151,500	152,000	152,771	1,152,205	1,179,247	— 2
Daily average	4,887	4,903	4,928	4,742	4,853	
Refinery stocks	256,500	251,965	236,337	256,500	236,337	+ 9
Days supply	52	53	46	52	46	

*Unless otherwise stated all figures represent thousands of barrels. (p) Preliminary. ***Does not include input wells.
‡Total demand, including exports.

Economic Position of U. S. Petroleum Industry

Eight Months Ending August 31, 1946

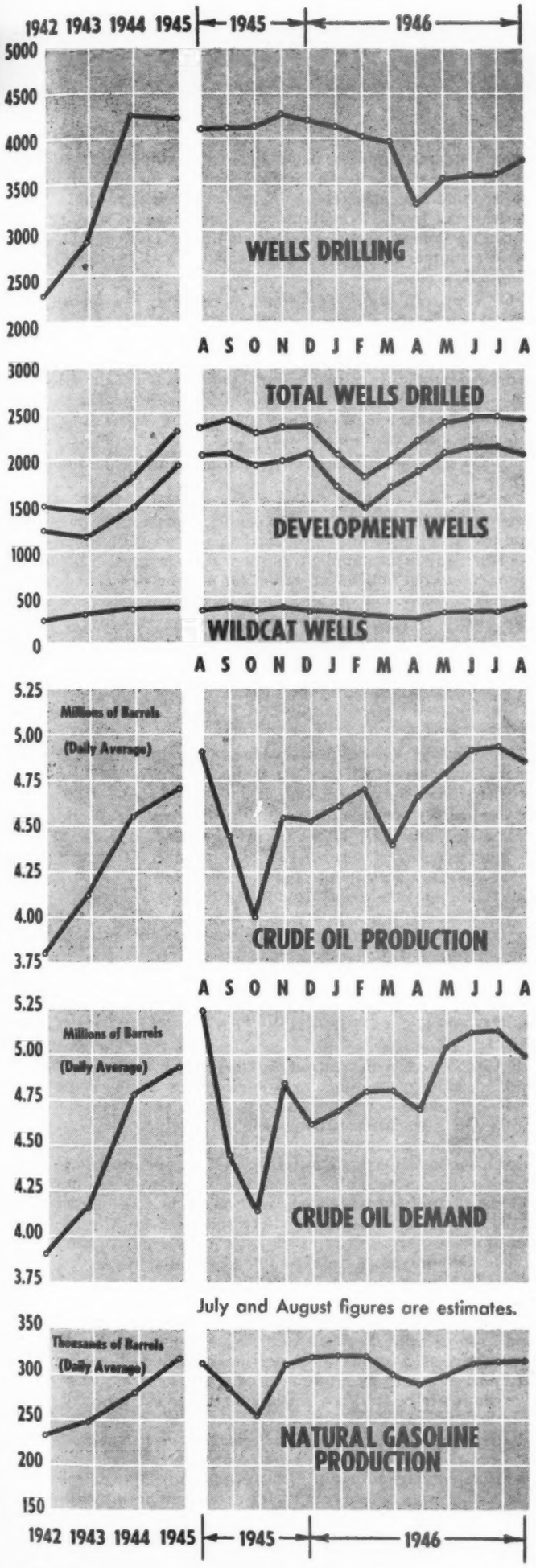
	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	18,225	18,750	103
Production (daily crude output)	4,736	4,744	100
Refining (daily still runs)	4,678	4,742	101
Stocks (crude and refined)	485,040	486,150	100
Price of crude (per bbl.)	$2.41	$1.56	65

Crude Prices by States for August, 1946

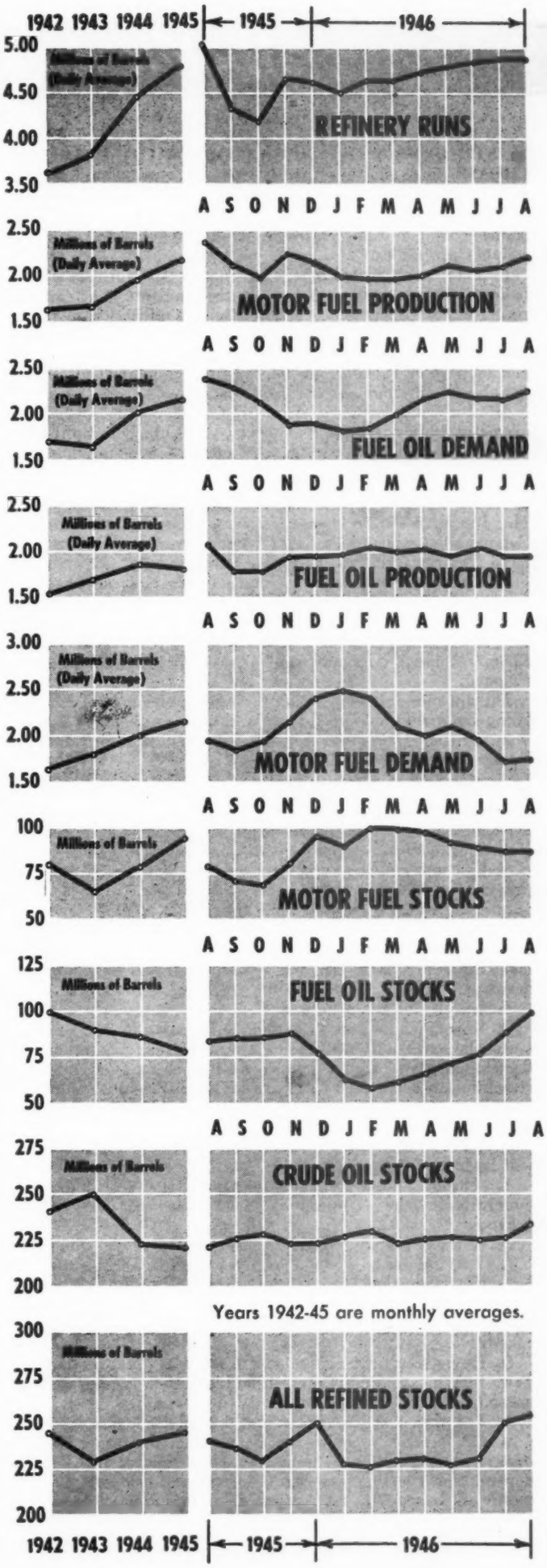
U. S. average	$1.56	Louisiana	$1.57	Basic crude prices	
Texas	1.56	Arkansas	1.38	Oklahoma-Kansas (36 gr.)	$1.62
California	1.41	New Mexico	1.38	Texas Gulf Coast (36 gr.)	1.75
Oklahoma	1.58	Mississippi	1.37	East Texas	1.60
Kansas	1.57	Illinois	1.74	West Texas (36 gr.)	1.39
		Other states	2.20	Calif. Signal Hill (26 gr.)	1.46
				Pennsylvania, Bradford	3.10

Drilling and Production Statistics by States

	Aug. 1946(p)	July 1946(p)	Aug. 1945	This year to date	Last year to date	Per cent change
Total wells drilled	2,476	2,508	2,346	18,750	17,659	+ 6
Texas	677	670	633	5,299	4,752	+11
California	86	151	207	1,138	1,568	—28
Oklahoma	283	289	229	1,744	1,631	+ 7
Kansas	178	175	155	1,305	1,122	+16
Louisiana	127	107	89	865	726	+19
Arkansas	14	13	19	114	114	0
New Mexico	34	26	31	248	279	—11
Mississippi	13	13	32	162	236	—31
Illinois	203	231	166	1,484	1,126	+32
Other states	861	833	977	6,391	6,105	+ 5
Wildcats drilled	406	369	339	2,708	2,710	0
Texas	151	130	119	1,041	1,072	— 3
California	28	16	24	154	162	— 5
Oklahoma	51	50	52	311	312	0
Kansas	32	25	36	195	253	—23
Louisiana	29	22	12	164	116	+41
Arkansas	5	2	0	25	25	0
New Mexico	1	0	9	29	50	—42
Mississippi	5	4	16	50	88	—43
Illinois	48	58	32	300	228	+31
Other states	56	62	39	439	404	+ 9
Daily crude production	4,863	4,951	4,870	4,744	4,825	— 2
Texas	2,138	2,248	2,193	2,093	2,172	— 4
California	877	877	920	863	920	— 6
Oklahoma	382	381	389	377	376	0
Kansas	278	273	266	262	268	— 2
Louisiana	396	390	362	381	357	+ 7
Arkansas	76	74	77	76	80	— 5
New Mexico	105	102	103	100	104	— 4
Mississippi	72	66	54	61	51	+20
Illinois	208	209	208	208	207	0
Other states	331	331	298	323	290	+11



July and August figures are estimates.



Years 1942-45 are monthly averages.

Highlights IN OILDOM

● **STRIPPER WELL OPERATORS WANT PRICE INCREASE.** H. C. McClure, Alma, Michigan, president of the National Stripper Well Association, has indicated that an increase of 25 cents a bbl. in the price of crude oil will be asked of purchasing companies by his organization in a move "to protect stripper properties."

In a statement issued by the association McClure said: "We believe the petroleum industry should take into consideration recent action of the Office of Economic Stabilization in reducing the stripper subsidy and offset that loss with an additional 25 cents a bbl. increase in order to protect the stripper wells and their reserves in the present and future interest of our national economy and security."

McClure said further that his group believed the OES acted prematurely in reducing the subsidy, particularly as applied to those areas where the recent price increase was insufficient to cover the subsidy loss.

● **PENNSYLVANIA GRADE CRUDE PRICES ADVANCED.** The Joseph Seep Purchasing Agency of the South Penn Oil Company has advanced prices for Pennsylvania grade crude oil 20 to 26 cents a bbl , retroactive to September 1.

Crude oil in the Southwest Pennsylvania lines advanced 20 cents to $3.20 a bbl.; Eureka lines, 26 cents to $3.20 a bbl., and Buckeye lines, 26 cents to $3.16. Waverly Oil Works increased the price of Zanesville grade crude in Buckeye lines 26 cents to $2.86. Bradford, Allegany, and Corning crudes remained unchanged.

The advance followed action the week previously of Elk Refining Company in posting $3.20 a bbl. for crude oil in Eureka lines. Previously South Penn had advanced Bradford and Allegany crudes 6 cents a bbl.

● **HOLMAN EXPECTS OIL RESERVES TO BE AS GREAT IN 20 YEARS AS TODAY** United States proved oil reserves are expected to be as great in 20 years as they are today, Eugene Holman, president of Standard Oil Company (New Jersey), declared recently, during an interview on the National Hour radio program over National Broadcasting Company.

Interviewed by Robert St. John, Holman also said that in order to satisfy the demands of the future the country will depend partly on imports to supplement its domestic supply, and will make oil from natural gas, coal and shales if the economic need develops.

Text of the interview follows:

Q. How much longer can we look to the earth for oil?

A. The earth will continue to give us oil for generations. In the United States alone we estimate that there is as much oil remaining to be found as has already been produced since the industry began. The resources of the rest of the world, which are much greater than ours, are still largely undeveloped.

Q. Well, what do you think the oil situation of this country will be in, say, 20 years?

A. The oil industry expects its proved reserves—its known underground working stocks—to be as great in 20 years as they are today.

Q. How can that be? We will be using oil all along, won't we?

A. Yes, but we will also continue to find it. During the war our efforts were turned to production while exploration lagged. But today oil explorers are hard at work uncovering new sources, and we are certain that oil will continue to be found in large quantities.

Q. If our reserves in 20 years are to be as great as they are now, that means that we must find as much oil as we use, doesn't it?

A. Yes, that is true, but not all of this oil need come from our own soil. In order to satisfy the demands of the future without drawing too heavily on our reserves, this country will have to depend partly on imports. But these will not *compete* with domestic oil. Instead, they will *supplement* production at home and enable the industry to stay strong and keep its reserves at a safe level. As a matter of fact, we shall never actually run out of oil. Should natural supplies show signs of diminishing, we shall utilize other sources to an increasing extent. In addition to imports, there are, for example, natural gas, coal, and oil shales to draw on. In the long run, coal alone offers an almost inexhaustible domestic source of oil products. The conversion of these resources to oil is perfectly feasible and awaits only the economic need.

Q. What you say, Mr. Holman, is certainly reassuring. But what about national emergencies which would demand sudden increases far beyond normal production?

A. No oil man thinks of his country's future without considering the possibility of national emergencies. On such occasions we would, of course, have to draw much more heavily on our reserves. That is one of the main reasons why we must maintain a healthy, progressive oil industry.

Q. On the whole, then, you are optimistic about the future of oil.

A. Yes, we in the oil industry are optimistic. We intend to keep on looking for new oil. We expect to make the production and use of oil more and more efficient We want the country to get better products and plenty of them at lower prices. Oil means too much to our entire civilization for us even to contemplate a shortage. Today, our oil position is sound. We want to keep it that way.

● **COMPACT MEETING DECEMBER 9-11.** Winter quarterly meeting of the Interstate Oil Compact Commission will be held in the Adolphus Hotel, Dallas, Texas, December 9, 10, and 11, it is announced by Governor Robert S Kerr, Compact chairman, and Sidney Latham, Texas representative on the commission.

Monday, December 9, is set aside as committee day. All Compact's committees will meet that day, preparing reports and special studies for presentation at the general sessions. Regular sessions of the commission will be on December 10 and 11.

Headquarters office of the commission has obtained a block of hotel rooms and reservations should be made through the commission's offices in the State Capitol building, Oklahoma City, Oklahoma, it is announced.

Preliminary program plans will be discussed at meeting of the Executive committee to be held September 28 in Oklahoma City. States of Illinois and Arkansas, added to the committee at the recent Grand Rapids meeting, will be represented by Clarence T. Smith and O. C. Bailey, respectively.

● **TO MAKE CORROSION TESTS ON PRODUCING WELLS.** Experiments will be conducted on 25 oil wells in the Oil City-Pleasantville district to test several laboratory-developed ideas for controlling corrosion in oil producing operations under air-gas secondary recovery. The Pennsylvania Grade Crude Oil Association will sponsor the study.

C. E. Stout of Parkersburg, West Virginia, production research engineer for the association, said six operators have consented to cooperate in the tests on nine separate leases throughout the district. Arrangements were made in conjunction with R. B. Bossler of the Brundred Oil Corporation, Oil City, a member of the association's research advisory committee.

The Battelle Memorial Institute, Columbus, Ohio, was engaged last year to make a special investigation of the corrosion problem for the association. The field trials will carry out the Institute's suggestion for investigation of use of zinc chromate and a preparation known as Calgon, either in combination or separately, as a means of protecting present well equipment. Temporary benefit might be derived from use of a rust preventive coating to be swabbed outside the tubing each time the well is pulled, the Institute said.

Other suggestions included elimination of galvanic couples between the brass barrel and the adjacent steel parts by means of insulated section or use of zinc protectors. Galvanized rods and tubing were recommended for use in replacements.

The corrosion study has been under way for some time as part of the oil association's production research program.

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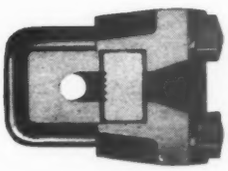

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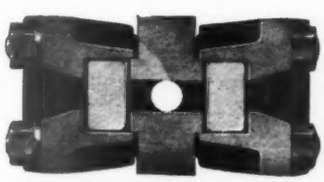

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PENBERTHY PRODUCTS

MAJOR *Oil Field* ACTIVITIES

● **OKLAHOMA.** Prospective pool opener for Garvin County is Carter Oil Company No. 1 Eskridge, NE NW SW 19-4-2w. The well flowed 689 bbl. of fluid in 23½ hr., of which 1 to 13 per cent was water and from 12 to 39 per cent basic sediment. Total depth is 7700 ft.

Garvin County has a new oil pool at Carter Oil Company No. 1 Burford, CNW NW 5-1-1w. The well flowed 360 ft. of clean oil with an estimated 2,000,000 ft. of gas on a drillstem test with packer set at 6018 ft. The oil flow was estimated at a rate of 10 bbl. an hr., and the crude tested 41.5 gravity corrected, from the Pennsylvania formation.

Hughes County has a new oil pool at B. C. Deardorf No. 1 Gentry, NW NW NE 14-7-9, four miles west of Holdenville. The wildcat flowed an estimated 200 bbl. of oil a day through tubing. The Booch sand was reached at 2874 ft., and total depth is 2895 ft.

A new gas pool has been opened in Pontotoc County, west of the Bebee oil district, at C. L. Carlock No. 1 Larmon, NW SW SE 31-5-4. The well produced between 12,000,000 and 15,000,000 cu. ft. of gas a day with some condensate showing with the gas. It was drilled to a total depth of 2012 ft.

Big Chief Drilling Company No. 1 Stephens, CSE SW 24-5-2w, has opened a new oil pool in McClain County, one-half mile southwest of Wayne. From the Pennsylvania sand at 6540-58 ft., the well flowed 286 bbl. of 42-gravity oil in 13 hr., through a ½-in. choke, with gas estimated at 790,000 cu. ft.

Prospects are bright for the opening of a shallow oil pool in Garvin County at W. D. Garrison No. 1 Billman, NE NW NW 16-2n-3e, eight miles east of Wynnewood. The well is estimated good for 50 to 75 bbl. of oil a day on the pump. The pay is at 1390-1440 ft.

● **CALIFORNIA.** British American Oil Producing Company No. 1 Bodger, SW 22-2s-14w, has opened a new oil field in the Laundale area of the Los Angeles basin, Los Angeles County. The well flowed approximately 50 bbl. of oil per hr. through 22/64-in. choke from a depth of 9154 ft. in a conglomerate.

● **ILLINOIS.** Sam Malis No. 1 W. L. Litherland, NW NW SE 20-1n-13w, promises to open a new pool for Wabash County. The well flowed 81 bbl. of oil an hr., or at the rate of 1944 bbl. of oil a day, from the O'Hara limestone at 2720-32 ft. Total depth is 2808 ft.

Joe Rignitz and others No. 1 Valter, SE SE NE 3-9s-9e, has opened a new pool three miles northeast of the old Junction pool in Gallatin County. Saturated Aux Vases sand was found at 2731 ft., and a core from 2733-38 ft. recovered 4½ ft. of saturated sand. A one-hour drillstem test at 2726-38 ft. yielded gas in 28 minutes, with no estimate of volume, 240 ft. of clean oil, and 60 ft. of oil cut mud.

Cumberland County has prospects of a new oil pool at National Associated Petroleum Company No. 1 B. J. Krogmann, NW NE SE 31-9n-7e, about 12 miles southwest of the Mattoon pool. A one-hour drillstem test from the McClosky limestone showed 900 ft. of gas, 578 ft. of clean oil, and 30 ft. of oil cut mud. Total depth is 2454 ft.

● **KANSAS.** Lion Chemical No. 1 Chance, NW NW 4-27-13w, has opened a new pool in Pratt County, two miles west of production in the Iuka pool. The wildcat produced 150 bbl. daily of 38-gravity from the Arbuckle.

● **TEXAS.** Continental Oil Company No. 1-B Lewis is showing prospects of opening a Bend conglomerate pool in central Montague County. The well showed 855 ft. of free oil on a drillstem test. The test, with tool open for four minutes, showed gas in one minute from 6340-50 ft., with bottomhole pressure of 2650 lb.

Brazoria County was assured of a new oil pool at Pan American No. 1 Callihan, 4650 ft. northwest of the Chocolate Bayou pool. On a drillstem test through perforations at 8757-62 ft. the well flowed at the rate of 12 bbl. of 40.2-gravity oil an hour.

Pan American No. 1-B Sternenberger promises to open a new pool for Hardin County. The well flowed oil and salt water on a drillstem test from open hole below casing at 9777 ft. Total depth is 10,808 ft.

A Navarro County wildcat has opened a new pool for that county, three miles south of Richland. The well, Temple Hargrove No. 1 Guy Wallace of Dallas, was flowing from the Rodessa at an estimated rate of 10 bbl. of fluid hourly, 50 per cent oil of approximately 25 gravity, and 50 per cent wash water. Total depth is 6185 ft.

A wildcat promising to open a new pool for Taylor County is West Central Drilling Company No. 1 Kinkaid, 27-16-T&P, four miles northeast of Tye. The King sand was found at 2616-60 ft., and on a 20-minute drillstem test 180 ft. of oil and 280 ft. of water were recovered. Total depth is 2710 ft.

A new pool has been opened at V. E. Autry and West Central Drilling Company No. 1 W. A. Minter estate, 39-2-SP, 14 miles southwest of Anson in Jones County. The well flowed through 2-in. tubing to bring an operator's estimate of 1200 bbl. of oil a day. Production is from the Swastika sand. Total depth is 3450 ft.

There are indications of another new pool for Jones County at Harry W. Elliott et al No. 1 Roberts, a mile east of Nugent. A good show of oil was reported in the Bluff Creek sand at 1645 ft.

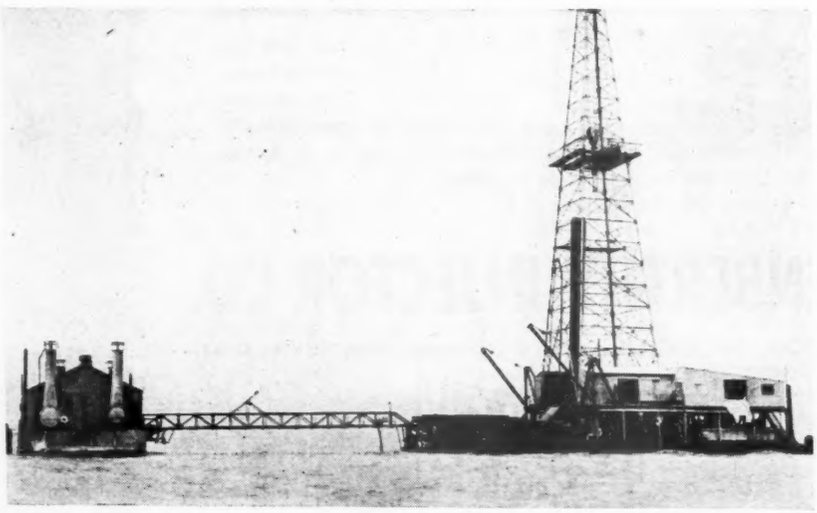
Stephens Petroleum Company No. 1 Slusher, nine miles southeast of Jacksboro, Jack County, may be a pool opener. The Caddo lime was reached at 4550 ft., and cored at intervals to get oil shows. On a drillstem test at 4537-63 ft., 210 ft. of oil-cut mud was recovered.

A new oil field has been opened in Throckmorton County at Fred M. Manning, Inc., No. 1 O. H. Parrott, wildcat, three miles from Woodson. The well flowed 50 bbl. of oil per hr. from the Caddo at 3895 ft.

Southeastern Fisher County has a new oil field at Skelly Oil Company No. 1 Huddleston. The well flowed 552 bbl. of oil in 23 hr. on potential test. Production was from 4325-405 ft.

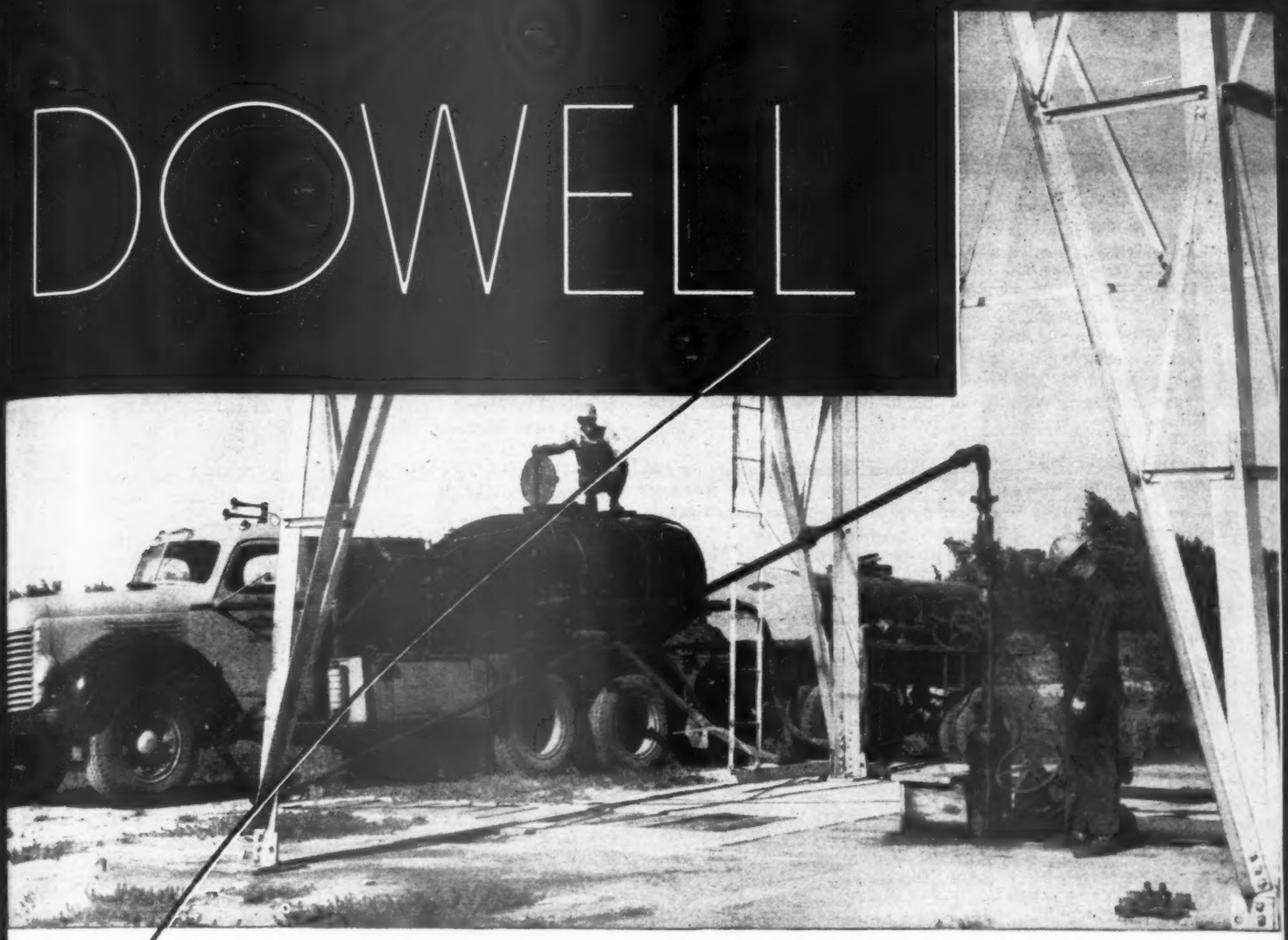
A. L. Amason No. 1 opened a new oil field in Wood County, which is Bobby Manziel's fourth field discovery in that county since 1940. The well produced at the rate of 10 bbl. of 20-gravity oil an hr. with no water from the Woodbine at 5466-88 ft.

Drilling from barge in Galveston Bay.



—Photo courtesy Humble Oil and Refining Company.

DOWELL



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MAJOR *Pipe Line* ACTIVITIES

● **LINE CONTRACT.** The Tennessee Gas and Transmission Company has awarded the contract for construction of 20 to 30 miles of 26-in. loop line on its natural gas pipe line to Morrison Brothers Construction Company of Odessa, Texas. This project is part of Tennessee's $29,500,000 expansion program. Construction will be in the states of Louisiana and Arkansas and the work is due to begin this month. The loop, together with 18 new compressor units and three new compressor stations, will increase the line's capacity about 40 per cent, of which three-fourths of the increase is expected to be supplied by "waste gas."

● **PETITION DENIED.** The Federal Power Commission has denied petitions for dismissal of its order to permit Reynosa Pipe Line Company to export natural gas to Gas Industrial de Monterrey, S. A., a Mexican corporation. The petitions were filed by two intervenors in the proceedings, Compania Mexicana de Gas, S. A., Mexico, and the Railroad Commission of Texas.

In June the FPC granted export authority contingent upon Reynosa's filing of an application for a certificate of public convenience and necessity for construction of approximately 30 miles of pipe line from the Hidalgo County, Texas, gas field to the Mexican border. Under a ten-year contract, Gas Industrial de Monterrey is to purchase gas from Reynosa at the border and pipe it to Monterrey for use by a limited number of industrial consumers who are subscribers to Gas Industrial's stock. The FPC order limited the gas exports to 50,000,000 cu. ft. daily of gas produced in LaBlanca, North Weslaco, and South Weslaco fields in Hidalgo County, Texas, from reserves owned by La-Gloria Corporation, parent company of Reynosa.

● **EXPANSION PROGRAM.** Northern Natural Gas Company, Omaha, Nebraska, has applied to the Federal Power Commission for permission to build 150 additional miles of pipe line in Nebraska, Iowa, and Minnesota and enlarge its entire system. The estimated cost of the work is $12,667,600. The company's pipe line system extends from Texas through Oklahoma, Kansas, Nebraska, Iowa, Minnesota, and South Dakota.

● **TRANS-JORDAN RIGHT-OF-WAY.** The Trans-Arabian Pipe Line Company, of which the Standard Oil Company of California owns 50 per cent along with The Texas Company, has been given permission by the Trans-Jordan Government for the trans-Arabian crude pipe line right-of-way through that country. A spokesman for the Standard Oil Company stated that definite plans for the Mediterranean terminus of this 1200-mile line have not yet been made. Trans-Arabian also has permission for right-of-way through Palestine, but in the case of Trans-Jordan's right-of-way permit, the company will pay that country approximately $250,000 yearly. The Palestine concession is free of charge. Trans-Jordan has also signed right-of-way agreement with Lebanon.

● **VENEZUELA LINE.** A 135-mile pipe line from Venezuela's Las Mercedes field to the Caribbean port of Guanta, a few miles east of Puerto de la Cruz, is under consideration. The production of the Las Mercedes field where the Las Mercedes Oil Company now has about 30 wells shut in, with more being drilled, will determine whether this line will be 14 in. or 16 in. Las Mercedes Oil Company is owned by Texas Petroleum Company, a Texas Company subsidiary, and Caracas Petroleum Company, owned by private British oil interests.

● **GAS LINE EXTENSION.** The Natural Gas Pipeline Company of America and Texoma Natural Gas Company have applied to the Federal Power Commission for permission to enlarge and extend their combined transportation system, at an estimated cost of $23,238,613. Texhoma asked authority to build 11 miles of 26-in. line and add nine 1250-hp. engines to its station in the Panhandle field, and make additions to the dehydration and gasoline plants operated in conjunction with the station. Natural Gas Pipeline proposes to add 39 compressor engines of 1250-hp. to its 9 existing compressor stations; to construct a new 6250-hp. compressor station and a dehydration plant near Guymon, Oklahoma; and the construction of about 35 miles of 26-in. loop line, 54 miles of 24-in. loop line, about 31 miles of 26-in. pipe line and approximately 42 miles of telephone line.

● **PIPE LINE COMPLETED.** Magnolia Pipe Line Company's new 10-in. line from Andrews station to the company's Midland terminal has been completed. It gives Magnolia three lines from Andrews to Midland. The new line will handle sweet crude.

● **SINCLAIR TERMINAL.** Sinclair Refining Company has begun construction of a $100,000 pipe line terminal along U. S. Route 127, one mile northeast of Bryan, Ohio. The project will include an office building and six 10,000-bbl. oil storage tanks. The terminal will receive fuel oil, gasoline, and kerosine from the 8-in. pipe line laid across Williams County several years ago and which is a short distance to the north of the terminal site. The contract has been awarded to the Weaver Construction Company, Bryan, Ohio.

● **HEARING OPENS.** The Michigan-Wisconsin Pipe Line Company wants to build an $84,000,000 pipe line from Texas to supply cities in Michigan, Wisconsin, Iowa, and Missouri. Max Ball, a geologist, testified at a power commission hearing that the storage capacity of natural gas fields of the Michigan-Wisconsin Pipe Line Company, is "well in excess" of requirements. The company's plans call for storing gas during off-peak summer months in the Austin and Reed City gas fields in Michigan. Ball estimated the storage capacity of these fields at 24,201,000,000 cu. ft.

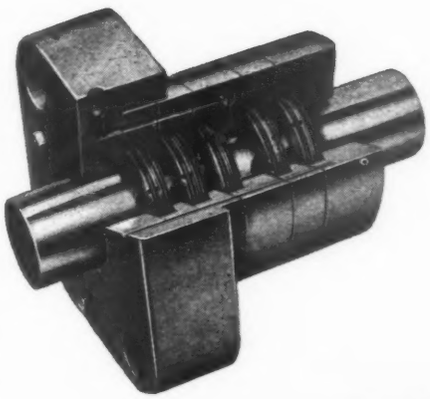
● **PIPE LINE UNDER BAY.** Humble Oil and Refining Company has filed application with the United States Engineering Office, Galveston, Texas, for permission to lay 2½-in. pipe lines under Dickinson Bay, about three miles east of Dickinson, in Galveston County. The lines will be buried 2 ft. below the bed of the bay.

● **NEW GAS LINE.** Pacific Public Service Company has awarded a contract to Pacific Pipe Line Construction Company for the construction of a new natural gas pipe line system from a point near Pittsburg, California, to the Suisun Bay, Kirby Hill and West Rio Vista gas fields, in Solano County. The estimated cost of the line is approximately $900,000 and it is scheduled for completion this year. The line will have a capacity of approximately 65,000,000 cu. ft. per day. The proposed line will be interconnecting with the Stanpac Pipe Lines, which connect the Bay area to Kettleman Hills and the East Rio Vista field.

● **PIPE LINE RECONDITIONING.** A $1,000,000 pipe line reconditioning program is being undertaken by Shell Pipe Line Corporation on its Texas lines. The program will include overhauling 81 miles of the company's Houston-Kilgore 10-in. trunk line, 19 miles of gathering lines to the East Texas field, and 42 miles of West Texas 6 and 10-in. trunk lines. An additional $700,000 will be spent to recondition 67 miles of 10-in. line between Healdton and Cushing, Oklahoma, and 38 miles of 6-in. line between Arkansas City, Kansas, and Tonkawa, Oklahoma. Contracts for the work have been placed with Anderson Brothers of Houston and Holland Construction Company of Tulsa.

● **U.S.S.R. CONSTRUCTION.** Surveying work for the gas pipe line to be built between Dashava and Kiev in the Ukraine has been completed and the first group of construction workers have arrived on the site, according to the Soviet press. The pipe line will be 323 miles long, second largest of its kind in the Soviet Union, and will carry natural gas from the Dashava area to the Ukrainian capital. Plans call for four compressor stations. The route crosses 92 rivers, 19 railroads, and many highways. Construction will begin on the 78-mile Dashava-Tarnopol stretch.

WHETHER YOU REQUIRE



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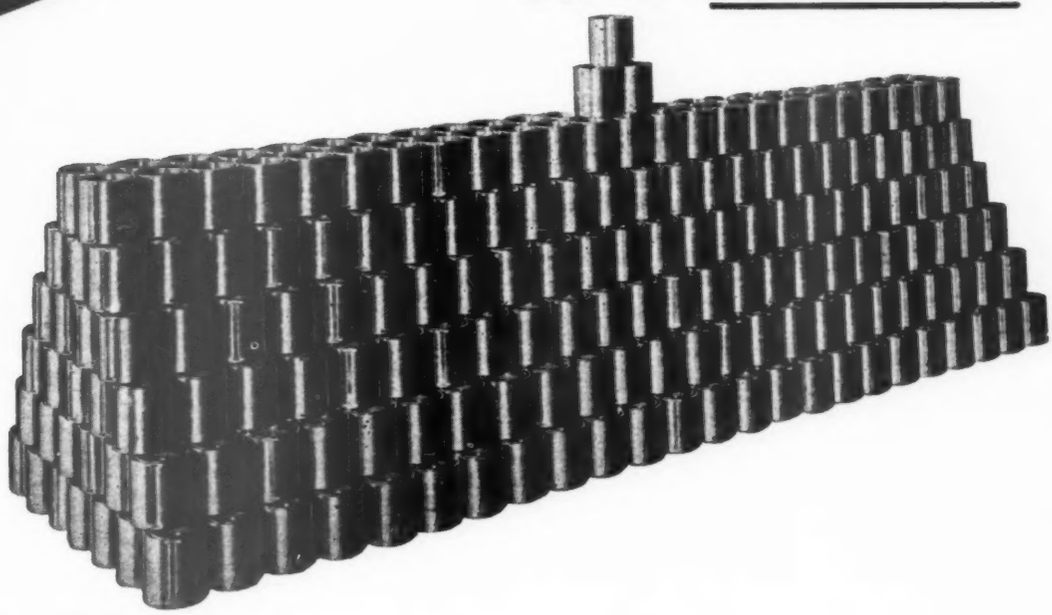

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MAJOR *Refining* ACTIVITIES

● **CARTHAGE HYDROCOL PLANT.** Carthage Hydrocol, Inc., New York, has announced plans to build a $19,000,000 plant to manufacture gasoline and other chemical components from natural gas near Brownsville, Texas. The Brownsville plant has been designed to process approximately 64,000,000 cu. ft. of natural gas per day and to produce 5800 bbl. of motor fuel daily, 1200 bbl. of synthetic diesel oil, and 150,000 lb. of alcohols.

The first application on a commercial basis of the Hydrocol process by Carthage is to be made at the Brownsville plant. The process is described as conversion of natural gas to a mixture of carbon monoxide and hydrogen, followed by a catalytic reaction to produce liquid hydrocarbons boiling substantially within the range of gasoline.

Eight companies, The Texas Company; Forest Oil Corporation, Bradford, Pennsylvania; Niagara Share Corporation, Buffalo, New York; United Gas Corporation, Shreveport, Louisiana; LaGloria Corporation, Corpus Christi, Texas; Stone and Webster; Gulf States Oil, Houston, and The Chicago Corporation, Chicago, are supplying $10,000,000 of the capital required. The RFC agreed to loan another $9,000,000.

● **CANADIAN PLANT.** Imperial Oil, Ltd., reports that it will erect the first catalytic cracking plant in Canada at Montreal East. This is part of a broad expansion program that includes a 4200-bbl.-a-day catalytic polymerization plant, it is stated.

● **ACQUIRE EAST COAST UNIT.** Standard Oil Company of California is making plans to acquire an interest in the Barber Asphalt Company's petroleum refinery and marine terminal near Perth Amboy, New Jersey. The Jersey refinery has a capacity of 15,000 bbl. daily and will process Gulf crudes for the California company, a Standard of California subsidiary now marketing petroleum products on the eastern seaboard.

● **BRAZIL REFINERIES.** The National Petroleum Council has authorized four separate Brazilian financial groups to present final proposals for construction of four refineries. Two refineries, one of 10,000 and one of 6000-bbl. daily capacity, are to be built in Sao Paulo, the other two refineries, each of 8000-bbl. daily capacity, are to be built in Rio de Janeiro. It is planned to operate the refineries on imported crude, and to distribute the refined products through the facilities of the five large oil companies now importing refined products into Brazil.

● **DEWAXING UNIT.** Humble Oil and Refining Company has awarded the contract for the design and construction of a 4600 bbl. per day solvent dewaxing unit at Baytown, Texas, to E. B. Badger and Sons Company of Boston, Massachusetts, to increase production of lubricating oils. The methyl-ethyl-ketone process, licensed by the Texaco Development Corporation, will be employed. It is anticipated that the plant will be placed in operation during 1947.

● **LUBE OIL PLANT.** Standard Oil Company of Ohio begins construction next spring of a large oil lubricating plant at Toledo, Ohio. The plant will cost $8,000,000 and have a capacity of 2000 bbl. a day. It will occupy 14 acres and appear as an extension to Standard's present refinery. The only actual buildings in the new plant will be those housing the filter, dewaxing, and control units. The company said that the plant should be completed in 1948.

● **CATALYTIC CRACKING UNIT.** Gulf Oil Corporation now has in operation at its Philadelphia refinery a new fluid catalytic cracking unit, one of the world's largest. The new unit was engineered and constructed by The M. W. Kellogg Company, petroleum engineers of Jersey City, and New York. This giant structure will serve as the focal point of all refinery operations at the Philadelphia plant.

● **CARTER REFINERY.** Carter Oil Company has announced plans for the construction of a new $8,000,000 refinery to be built at Billings, Montana. Company officials stated that the plant will be the largest of its kind in Montana and will include a catalytic cracking unit with a total capacity of 18,000 bbl. of crude per day. Actual construction will begin when engineers have completed the designs. The plant should be ready for operation in 1948.

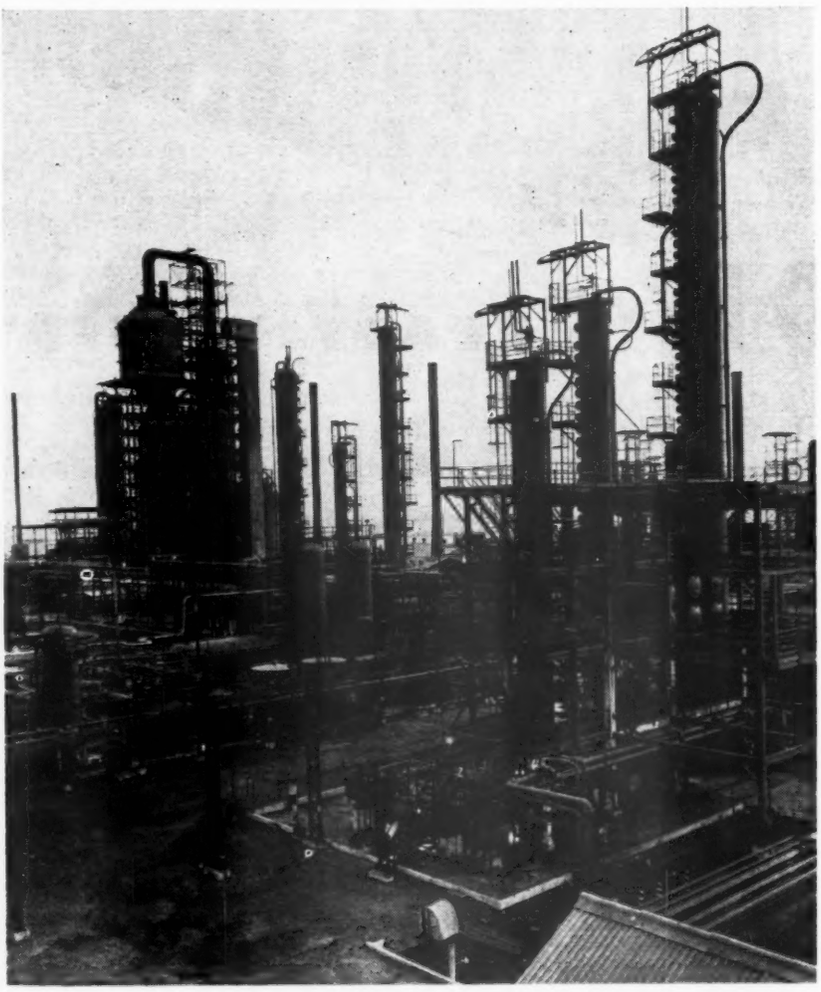
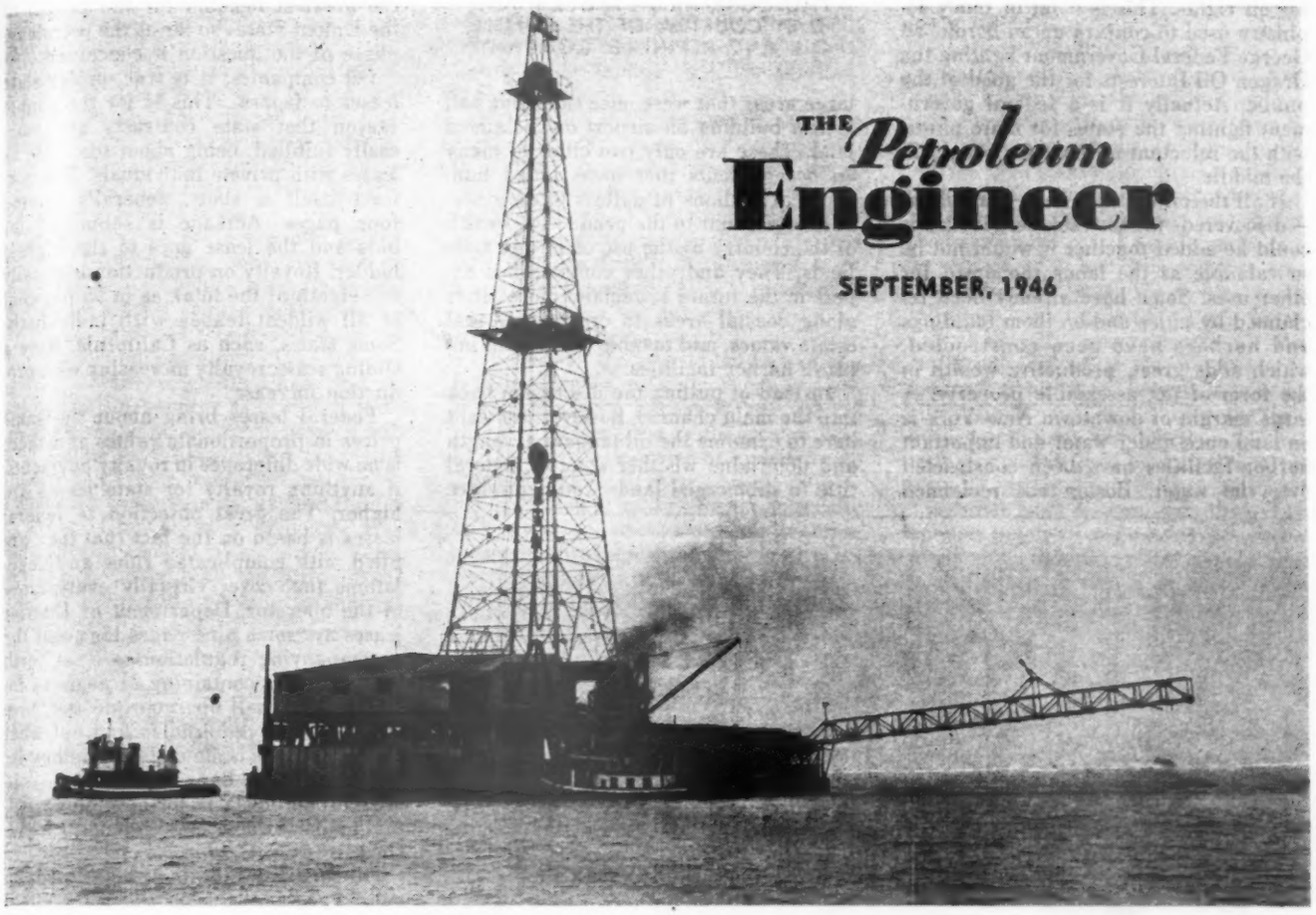


Photo by N. Morris, Standard Oil Company (New Jersey).

The fluid catalytic cracker (left background) and other units for producing high octane fuel at Aruba Refinery, Lago Oil and Transport Company, affiliate of Standard Oil Company (New Jersey).

● **REFINERY SETS RECORD.** The Aruba refinery of Lago Oil and Transport Company, Ltd., an affiliate of Standard Oil Company (New Jersey), in July exceeded four of its own all-time records for runs, receipts, and shipments. It is the first refinery in the world to process a billion barrels of crude. Situated on the island of Aruba in the Netherlands West Indies off Venezuela, the refinery handled a run of 11,059,000 bbl. for July to surpass the old mark of 10,403,000 established in June of this year. Other record performances were: Daily crude run, 416,000 bbl. on July 23; monthly crude and product receipts, 11,651,000 bbl., and crude and product exports, 12,012,000 bbl.



When a well in the Gulf of Mexico tidelands has been completed the big submergible barge rig is floated to the surface of the ocean and is towed by tugs to the next location.

Title to the tidelands

By **ERNESTINE ADAMS,** *Associate Editor*

THE question of whether the state or federal government owns the tidelands of continental United States is deeper in obscurities than the submerged coast is in water. The solution should be made with the aim of achieving the greatest possible benefit for the people of the nation but politics and precedent surge over the discussion until few are able to keep an eye on the objective.

EXCLUSIVE

Political theory and practice for the last 10 to 15 years have favored ever-growing federal power and ownership as being the most advantageous to the greatest number of citizens. This attitude gives the federal government an edge in its claim to title of marginal seas. Precedent, on the other hand, favors the states because their rights to submerged lands have not been challenged in a hundred and more years of assumption to possession, which may not receive the full nine points of law traditionally mentioned but requires definite disproof for any change that may be made. It was not until 1938 that Harold L. Ickes, then Secretary of the Interior, declared title to the tidelands rested in the United States government and not in the states themselves.

The claim culminated in a complaint filed by the Department of Justice before the Supreme Court last fall asserting federal title to offshore lands, roughly those lying between the low tide mark and the three-mile limit, along the California coast. Forty-five states joined California in its fight to hold the submerged lands; inland states entered the dispute on the premise that an affirmative decision would threaten title to land under all navigable water, inland as well as along the coast, and with the knowledge that the several states acquired title to lands beneath inland navigable waters in exactly the same way and at precisely the same time that they became sovereign proprietors of the tidelands within their maritime boundaries.

Congress passed a bill that renounced all claim by the federal government to this submerged coast land but it was vetoed by President Truman August 1 on the theory that said ownership should be determined by the Supreme Court. Debate on the case will begin when the Court begins its fall session in October.

To all appearances oil development off the shore of California in the Pacific and off Louisiana and Texas in the Gulf of Mexico inspired the federal claim so oil is the direct cause though not the essence of the matter. Ickes simplified the case into a dispute between the federal government and private oil concerns

for oil rights. This is a bit of fancy sophistry used to conjure up an heroic St. George Federal Government fighting the Dragon Oil Interests for the good of the public. Actually it is a federal government fighting the states for more power with the reluctant oil industry caught in the middle.

If all the oil that has been—or will be—discovered in the submerged lands could be added together it would not be so valuable as the lands reclaimed for other uses. Some have already been reclaimed by cities and on them buildings and harbors have been constructed, which adds great, productive wealth in the form of tax assessable property. A large margin of downtown New York is on land once under water and important harbor facilities have been constructed over the water. Boston has reclaimed large areas that were once tidelands and is now building an airport on reclaimed land. These are only two cities of many on ocean fronts that have added hundreds of millions of dollars to their taxable assets and to the productive wealth of the country by the use of former tidelands. They and other communities expect in the future to reclaim more lands along coastal areas to create new real estate values, add taxable assets, and improve harbor facilities.

PHOTOGRAPHS ON PAGES 51 AND 52 BY COURTESY OF THE HUMBLE OIL AND REFINING COMPANY.

Instead of pulling the discussion back into the main channel, however, we want here to examine the oil tangent at length and determine whether state or federal title to submerged lands would produce the greatest benefits for the people of the United States so far as the petroleum phase of the question is concerned.

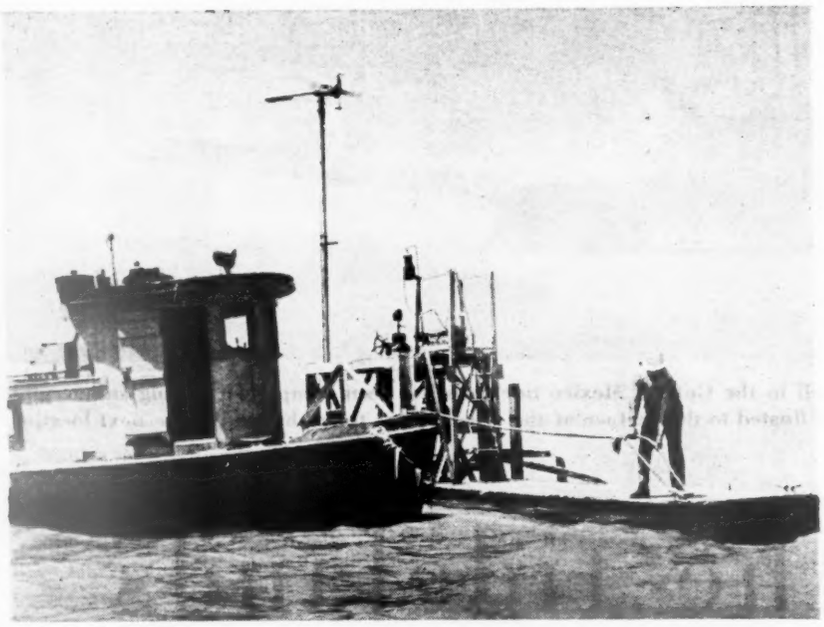
Oil companies, it is true, prefer state leases to federal. This is for the simple reason that state contracts are more easily fulfilled, being about the same as leases with private individuals. The contract itself is short, generally around four pages. Acreage is submitted for bids and the lease goes to the highest bidder. Royalty on production is usually one-eighth of the total, as in 95 per cent of all wildcat leases with individuals. Some states, such as California, have a sliding scale, royalty increasing with production increase.

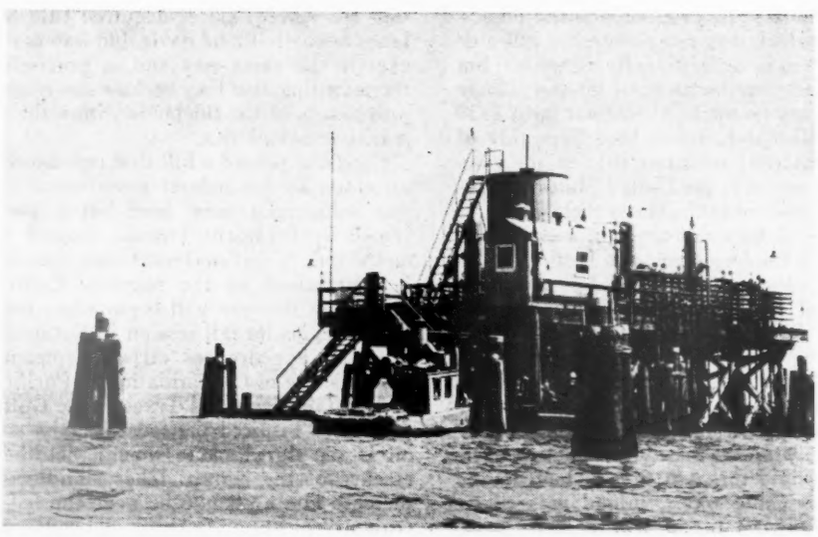
Federal leases bring about the same prices in proportionate values and there is no wide difference in royalty payments, if anything royalty for state leases are higher. The great objection to federal leases is based on the fact that they are filled with complicated rules and regulations that cover virtually every move of the operator. Department of Interior leases are some nine pages long and the accompanying regulations are set forth in a pamphlet containing 21 pages of instructions. Small operators do not have the personnel required to find out what all the red tape is, much less to follow it; large operators have been able to conceal any enthusiasm for developing federal lands as the figures on federal leases show.

Oil companies that now hold leases on submerged lands from the state might not agree, but actually the oil industry as a whole has greater interest in having more workable federal leasing contracts than in the ownership of tidelands, except insofar as it might be affected by increased federal power.

If an oil man wants to lease some land belonging to the U. S. government, for instance, he must first find out which one of some 25 departments or bureaus has control of that particular area. He can contract for a strictly limited acreage so if he discovers oil at the edge of his concession he cannot extend his holdings into adjoining government land. If an oil field is partly on government land, the rest on private property, it may not be possible to obtain permission to unitize the operation for greater efficiency in production, a move he could make without permission under most leases. In other words, even if he is fortunate enough to discover oil, he is hemmed in by rules that prevent expansion and development with modern efficient methods.

The reluctance of operators to rent federal lands for oil exploration is evident in the fact that only some 2,000,000 acres of the public domain are leased for that purpose out of some 785,741,424 acres available and only 689,654 acres are producing oil or gas. In the seven years ending January 1, 1943, some 21,000 wildcat wells were drilled in the United States but only 37 of these were spudded in on the public domain. In contrast to this unpopular showing the one state of New Mexico has some 5,000,000 acres of state lands under lease, which bring some $4,000,000 a year in-





Pumpers in a tideland field make their rounds by boat. Above, one is tying up at a producing marine well, which has the type of landing platform that is built at each well guard. The windmill on the well generates electricity for a light that burns constantly. Below is a typical production island in Galveston Bay. Production flows through lines buried in the bottom of the bay to this central separator island.

come to the state government although little of this sum is yet from production, which would increase the sum.

The general attitude of the oil industry is that it is too hard to do business with the federal government. If the tidelands become federal property, exploration and development of oil will undoubtedly slow down as they are already slowed in other federal lands.

The answer to the ownership of the tidelands, of course, does not rest on what the oil companies want. It should not depend upon acquiescent precedent or the political and economic theories of any one administration. The solution should assure the greatest gain and security for our country as a whole. Some oil firms would be inconvenienced if federal claims were allowed but the oil industry as a whole would not feel the effects much more than the general public.

Every citizen is to some degree concerned with federal ownership of land. At present more than one-third of the United States and its territories belongs to the federal government and is not taxable without congressional consent. In continental United States alone one-fourth of the land is owned by the federal government.

This means that this land is set aside from ordinary private development. No individual can build a permanent structure on the property to increase its value and the wealth of the nation. This land is not subject to ordinary taxation and taxes from two-thirds of the nation must take care of three-thirds of the country.

The acreage has increased in recent years and the administration has shown a tendency in the past to hold on to any land it acquires for special use. In California, the state named in the federal title suit, 46 per cent of the land is held by the central government and is therefore not taxable by state or local governments. Officials of California naturally do not want to see the state lose the large segment of taxable property that makes up the tidelands and supplies a yearly royalty of some $4,000,000, which is used for state parks and thus benefits the general public.

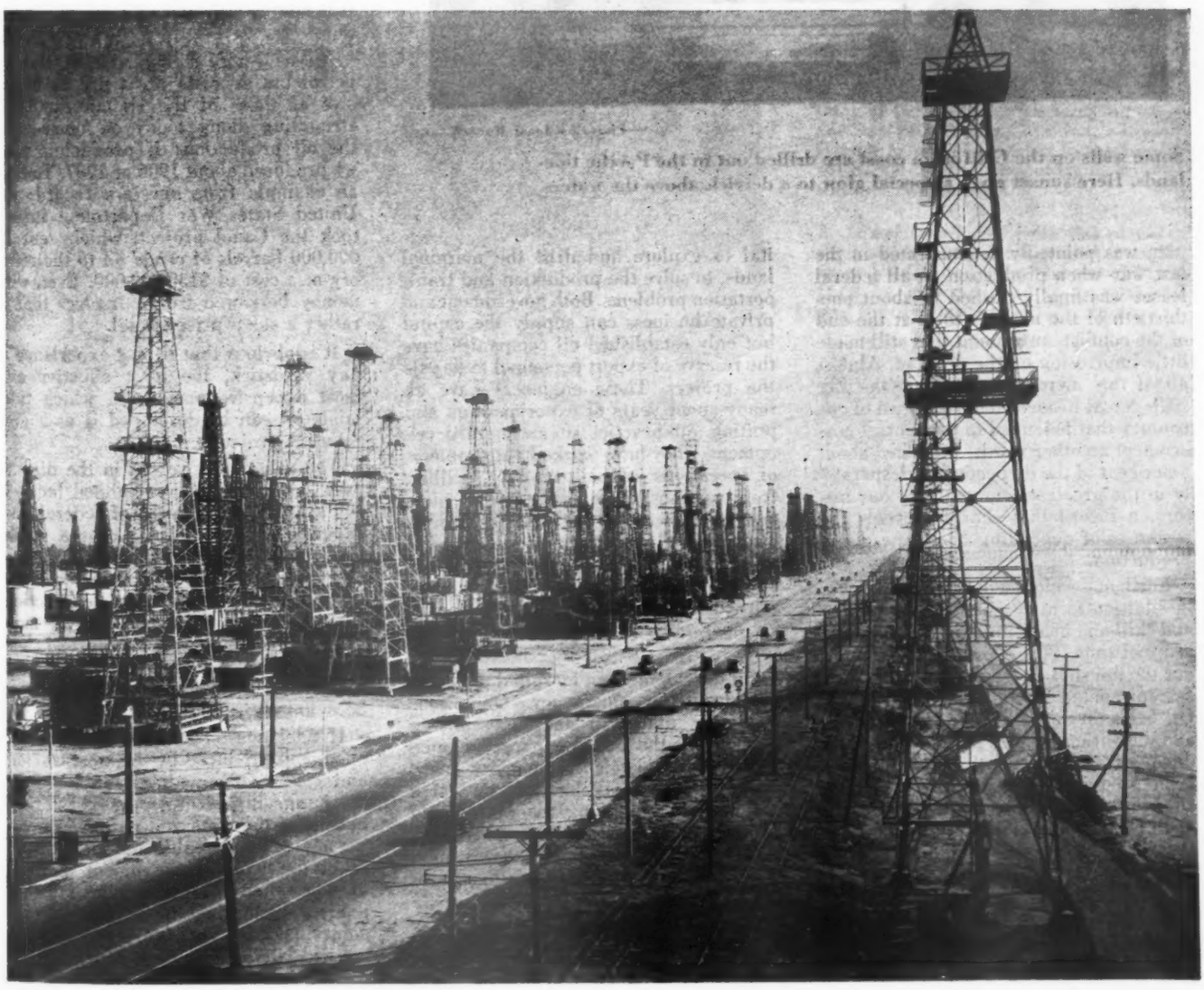
The loss of these assets would be felt principally by the people of California, however, and we will not claim it to be an essential item in determining the question of submerged land ownership.

Even the fact that acceptance of states' title seems to have worked out satisfactorily in practice as well as theory until the occurrence of oil development must be considered as merely a negative argument against change. We seek more definite reasons for quieting title.

It is true that state leases are fairly standard and there is no prejudice against them; that federal leases are cumbersome and retain wide authority over operations, making them difficult to follow precisely and leaving the operator too easily open to federal action. There has been also an unexpressed but definite policy of conserving oil on federal lands and holding back development to await national emergencies before production is utilized. The fallacy of this

These are directionally drilled wells along Long Beach, California. The oil is under the tidelands but the wells are drilled on the coast line and the drilling pipe runs down and out under the Pacific Ocean. The wells are closely spaced here but the holes may be bottomed hundreds of feet apart in the ocean bed.

—Photo by the Inman Company.



—*Photo by Josef Muench.*

Some wells on the California coast are drilled out in the Pacific tidelands. Here sunset gives a special glow to a derrick above the waters.

plan was pointedly demonstrated in the last war when production on all federal leases was finally pushed to about one-thirtieth of the nation's total at the end of the conflict, an amount that still made little impression on the demand. Almost all of this increase came from the Elk Hills Naval Reserve. The one-third of our country that belonged to the central government, in other words, produced about 3 per cent of the oil needed so desperately in the greatest emergency of our history, a record that sharply reveals the weakness of depending upon emergency production.

Efficient development of oil properties, in addition to high technical knowledge and skill and heavy investments, requires years of time. This is especially true under the unusual physical conditions such as represented by the submerged lands. Oil fields do not spring up, produce oil, and die within a short period. They produce for years. Several old wells have been producing since shortly after the Drake well began the U. S. oil industry in 1859. Virtually all major oil fields discovered in the United States are still producing or can produce.

If the tidelands oil is developed slowly and methodically, the work should go ahead without obstacles.

It requires much more than huge capital to explore and drill the marginal lands, to solve the production and transportation problems. Both government and private business can supply the capital but only established oil companies have the reserve of expert personnel to handle the project. These engineers have already spent years of experimenting and putting into practice sub-marine oil development. They have worked out problems of operations in shallow water, drilling from cassions, from barges, from piers and from shore with a directional drill. They have already tackled the problem of operations in deep water in open sea and the Buck Rogers contraptions being worked on today will provide the means for operations in deep open sea tomorrow.

Oil development in marginal seas cannot await an emergency. Operations would be difficult if not impossible to continue in the broad expanse of open water-covered lands if the chief emergency—war—came along. If any area was already producing the wells could be well camouflaged. This would still not be a particularly safe source to rely upon for use of the Navy, for instance, regardless of the state of development.

In time of war, all natural resources are available to the federal government, it should be pointed out here, and this would include all oil from the marginal lands whether they are the property of state or nation or private individuals.

One plan advanced by certain ideologists is that one or more of the national departments—Navy or Interior, for example—should take over the exploration and development of oil in federal lands and shut in production until it is needed for national purposes. This would cancel the lack of interest on the part of private operators to undertake fulfilling federal lease requirements.

There is very little in past history or present events to recommend this government or any other as an oil operator. In those countries where mineral rights are held by the government and acreage is leased to private companies for exploitation, such as many South American countries do, oil assets have grown and improved and been of benefit to the country and the operators. There is no record, however, of all-round successful oil development when it is attempted by the government itself. Mexico, for example, had become the second largest producer in the world under British and American companies. Production has dropped and no important discoveries have been made since the government nationalized its resources and turned operations over to a government company. It is now in fifth place for world production.

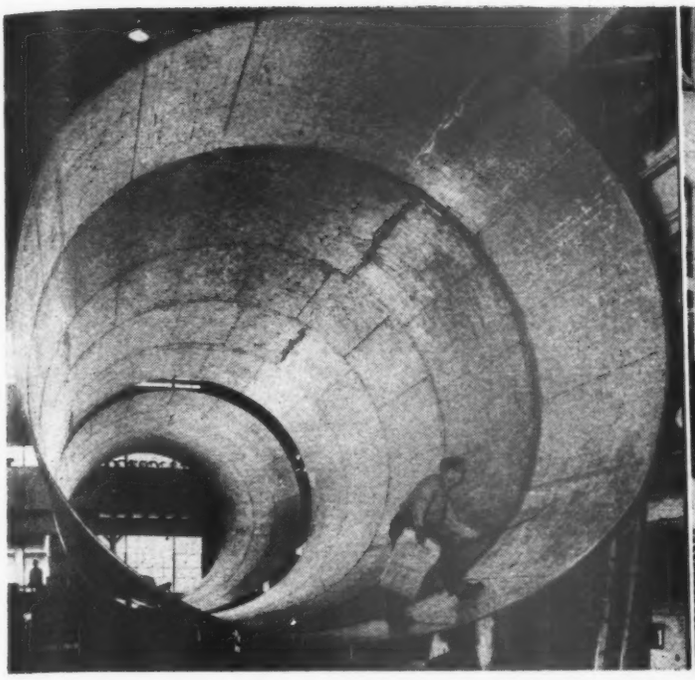
Russia, whose geological indications of petroleum deposits are twice as extensive as those of the United States, is struggling along today on one-twelfth the oil production; is producing what we produced about 1906 or 1907. To take an example from our own record: the United States War Department undertook the Canol project, which sent 1,000,000 barrels of crude oil to the refinery at a cost of $130,000,000. Even with money borrowed from ourselves that is rather a steep price for oil.

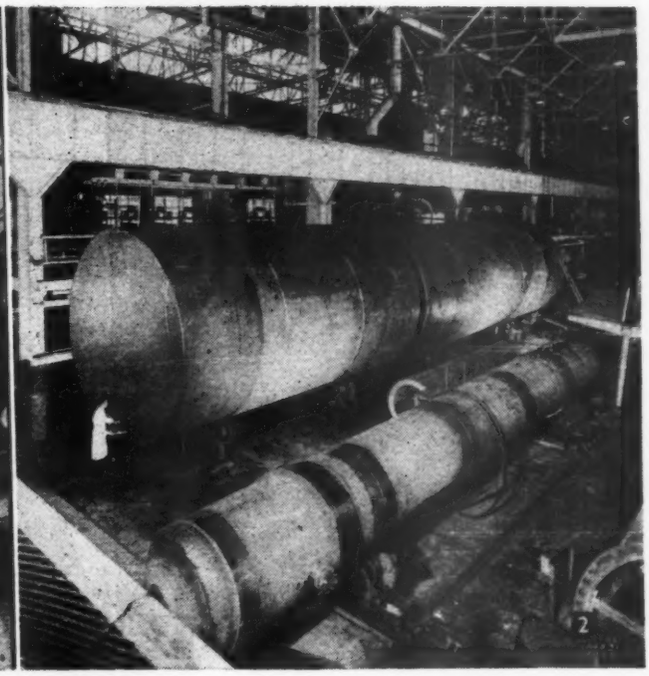
It is obvious that if past experience is any yardstick, the least effective and most expensive manner in which tidelands oil can be developed is as a government project.

The principle involved in the dispute over submerged and reclaimed lands is the extent of the power of federal government over the rights of the states. Control of the development and production of oil that may be discovered in the areas is simply the immediate practical side of the problem, one that is more quickly understood than the broad theoretical issue. The answer to the title question as it concerns oil, however, can be definitely stated:

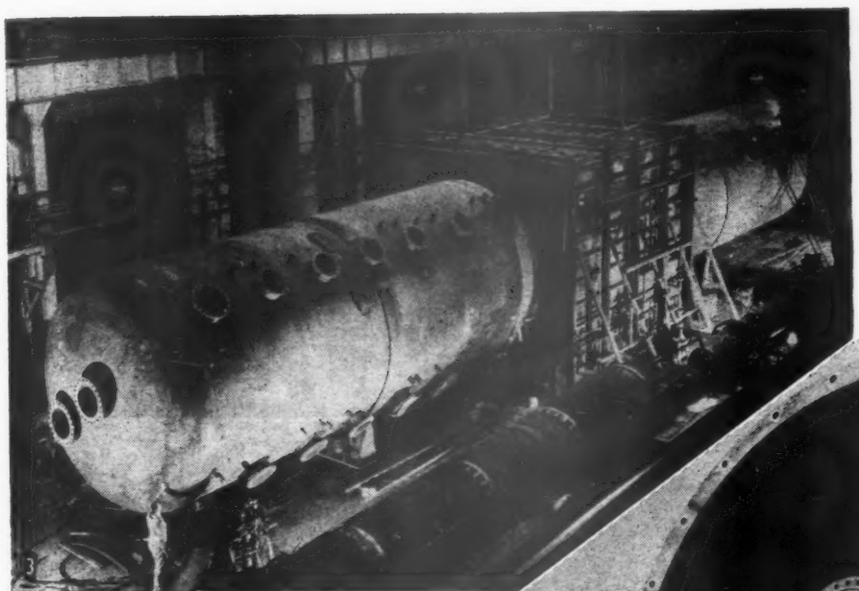
If tidelands oil is to be found, developed, and produced by the most efficient and least costly methods for benefit of the public in peaceful pursuits; for the benefit of the state and nation in creating new taxable wealth, and for the benefit of the federal government in event of war when oil production must be ready at hand, then the safest method of achieving this end is to leave the submerged lands under state control.

★ ★ ★





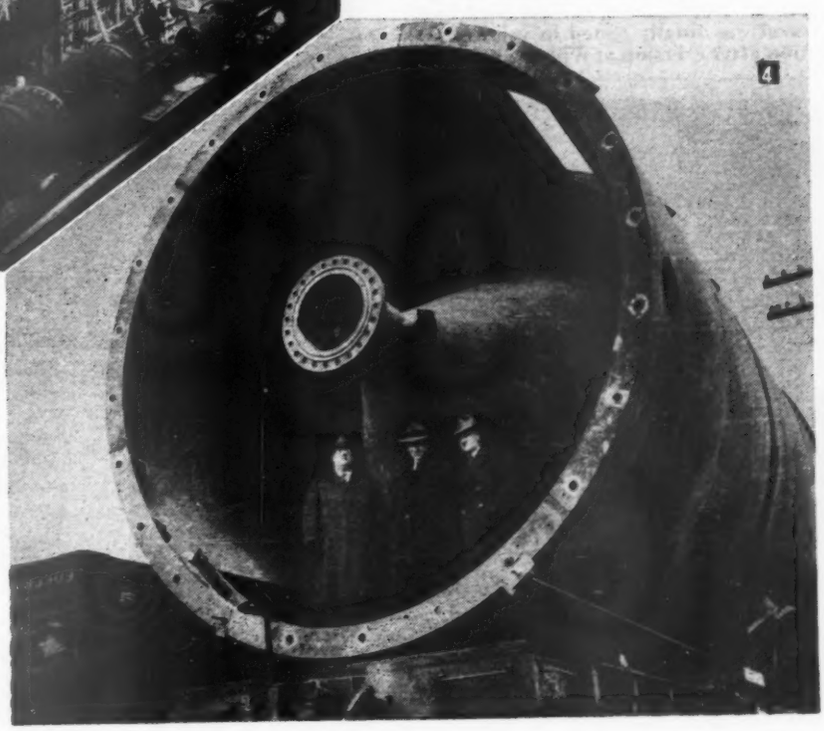
Build largest shop-made welded vessel



1. A shop-fabricated welded vessel larger than any ever made before was manufactured for Standard Oil Company of Indiana as a fractionating tower for use in Whiting, Indiana, refinery. Here it is being inspected in the factory of A. O. Smith Corporation, in Milwaukee, Wisconsin.

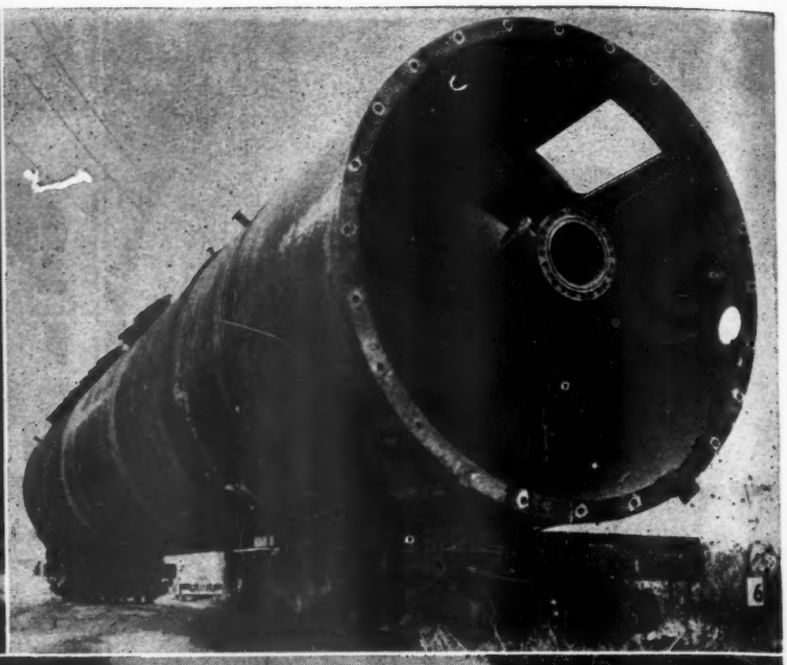
2. It was fabricated from flat plates of steel welded into 9 rings and then the rings welded together. The vessel is 106 ft. 8 in. in length, 16 ft. in diameter and the wall thickness is ¾ in.

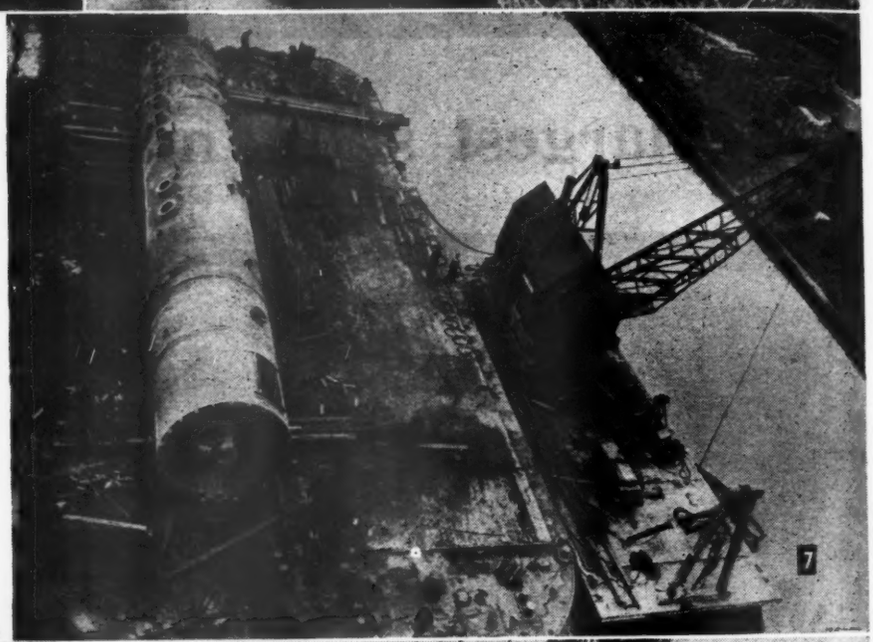
3. No furnace was large enough to heat treat vessel so a special furnace was built around it and it was heat treated by sections after assembly. There was approximately 800 ft. of welding. The tower was shipped six months after work was begun.



4. Weighing 320,500 lb. and too large for railroad shipment the 125 miles to Whiting, the tower was transported by rail to the lakefront and shipped by barge. Here the vessel has been loaded on two flat cars for the 4-mile trip to the lakefront.

A **Petroleum Engineer**
PICTURE STORY





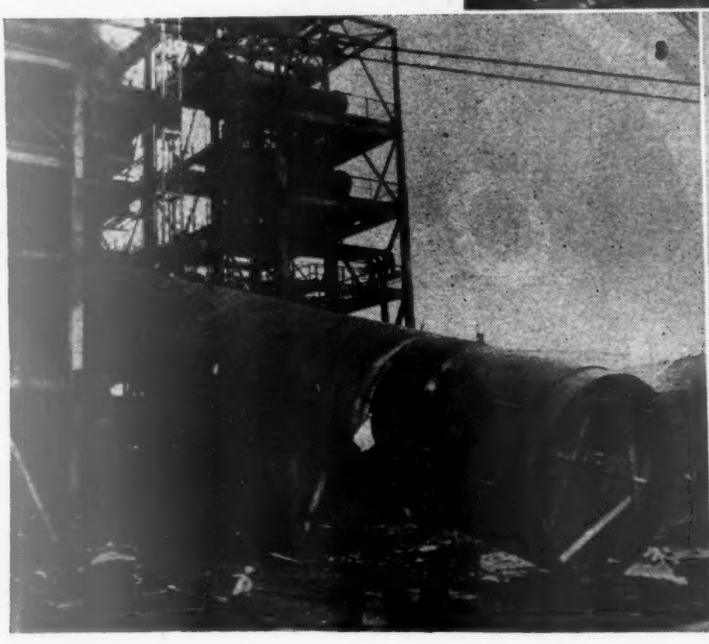
5. Flat car floors had to be lowered so tower could clear bridges; clearances were less than 2 in. in several places.

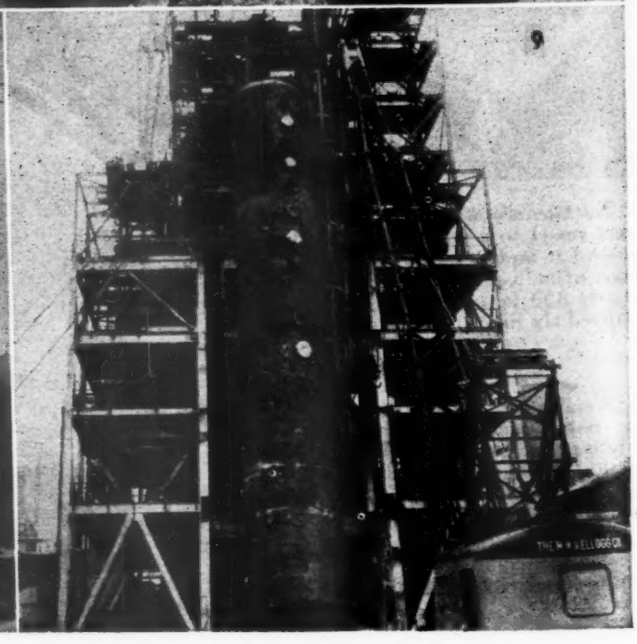
6. Locomotive, in despair, jumped track at lakefront terminal but finally was conveyed the last lap to barge.

7. Vessel was skidded sideways on rollers from flat cars to barge, operation requiring two nights and one day. Tug for barge is largest on Lake Michigan.

8. Cold weather slowed erection of tower. It was not until January that the giant vessel was raised into its place.

9. Because of its size the hydrostatic test could not be made while vessel was in horizontal position or weight of water (1,250,000 lb. of water was required) would have caused buckling. Vessel was finally tested in vertical position after erection at Whiting refinery.





Selection of internal-combustion engines for field use

By **JAMES MOON**

EXCLUSIVE

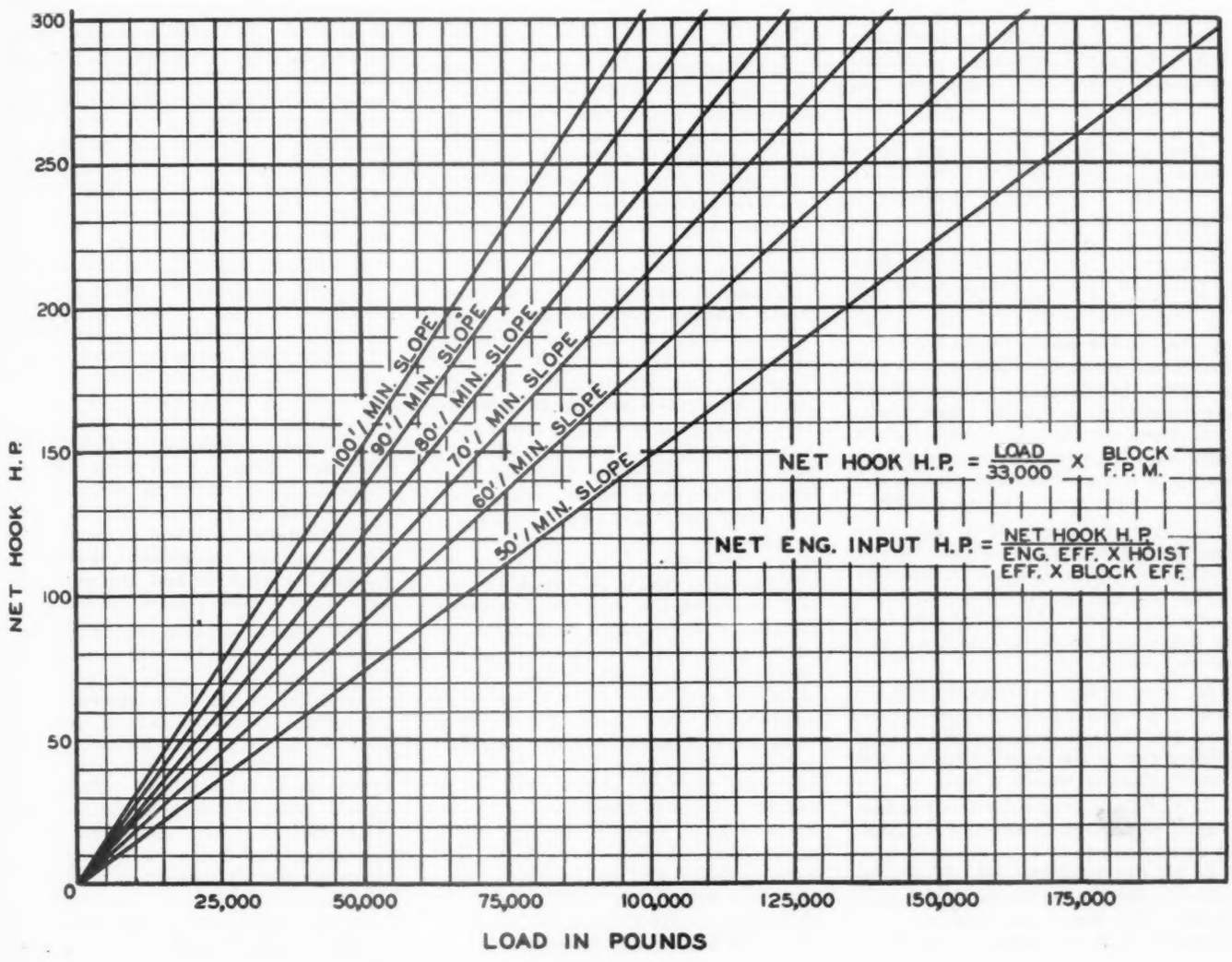
THE choice of an engine for any particular oil field purpose must of necessity involve a consideration of many factors. The prospective effects of most of them, fortunately, can be determined in advance by well established mathematical processes. There are intangibles, however, such as availability of parts, simplicity of operation; service life; general adaptability to environment, and the quality of operating personnel required, all of which despite their intangibility must be weighed as carefully as possible in arriving at a decision.

● **Engine for hoist duty.** Assuming, for example, that we are required to select an engine for hoist duty, we must first consider what type of engine is most desirable—gas, gasoline, butane, diesel—taking into account availability of fuel and service. Then we must take cognizance of the type of unit, stationary, portable or semi-portable heavy drilling rig, light drilling rig, servicing—or combination drilling and servicing rig, on which the engine is to be employed. Finally, consideration must be given to the load that will be handled, the speed, range, and hook horsepower necessary, together with the net engine horsepower, and the gross engine or so-called "bragging" horsepower.

With these general qualifications defined, we now get down to specifics: Suppose the rig is to be equipped with a double-drum hoist, dual ratio drum, with either torque converter or gear box drive. the maximum line speed required, based on the fastest permissible return speed of the blocks, is, in a short derrick, that is, 60 to 90 ft., about 250 to 300 ft. per minute. In tall derricks, block speeds up to 350 ft. per minute are used, the high line speed being accomplished through the high-speed drive end of the hoist. Maximum hoist line speeds vary on different types of hoist from 950 to 2400 ft. per minute, the larger hoists in general having higher line speeds, because of the greater number of lines.

Maximum line pull required is based on the load to be lifted, the capacity of the pulling or fast line, and the number of lines up in the derrick. The hook load should be balanced with the rest of the equipment, and it is desirable to start the load off bottom at a rate of 60 to 90 ft. a minute. The engine selected should thus have sufficient capacity to lift 10,000 ft. of 2½-in. tubing wet off bottom at 90 ft. a minute, and the specific determination may then be made as follows:

FIG. 1.



Net hook horsepower

$$\text{Net hook hp.} = \frac{\text{*Load} \times \text{F.P.M.}}{33{,}000}$$

$$= \frac{81{,}000 \times 90}{33{,}000}$$

$$= 221$$

*10,000 ft. 2½-in. tubing wet weighs 81,000 lb., approx.

Net engine input horsepower

$$\text{Net eng. inp. hp.} = \frac{\text{Net hook hp.}}{\text{Eng. eff.} \times \text{hoist eff.} \times \text{block eff.}}$$

Assume engine efficiency to be 85 per cent (it varies from 70 to 85 per cent).

Assume hoist efficiency to be 85.

Assume block efficiency to be 96 (it varies with number of lines up—four considered here).

$$\text{Net eng. inp. hp.} = \frac{221}{.85 \times .85 \times .96}$$

$$= 320$$

We have, therefore, established that 320 net input hp. will lift 10,000 ft. of 2½-in. tubing wet, weighing 81,000 lb., off bottom at 90 ft. a minute.

With four lines up,

the line pull =

$$\frac{81{,}000 \text{ lb.}}{4} = 20{,}250 \text{ lb.}$$

Selection of proper size line

Breaking strength of improved plow steel 1-in line 84,000 lb.

$$\text{Giving a safety factor of} = \frac{84{,}000}{20{,}250}$$

$$= 4.15$$

Wire line companies usually favor a factor of 5, but the oil industry operates on factors of 2 to 4 for this purpose, so the foregoing line would completely satisfy the need in this case.

Line speed at 90 ft. a minute block speed is actually $90 \times 4 = 360$ ft. per minute, and this should be attainable in high second or low third, certainly never less than low second. The relationship between net hook horsepower and load in pounds for various lifting speeds, are shown in the curves, Fig. 1.

● **Engine for pump duty.** The selection of an engine for pump duty is also a matter that demands careful consideration of many pertinent factors, to wit:

a. Pump requirements based on hole size, drill pipe size, pressure losses, length of string, tool joints, bit size and type, annulus—pressure and volume.

b. Type of engine desired—gas, gasoline, butane, or diesel—on basis of fuel and service availability. It is obvious that whenever and wherever possible the pump engines should be of the same type as those used to power the hoist and rotary table.

c. Type of unit on which pumps are to be used—heavy drilling rigs—stationary, portable or semi-portable; light drilling rigs in the same categories, and combinations or workover rigs.

d. Choice of engine for this function is again dependent on ease and availability of service.

In all the incidental calculations involved in the choice of pump drive, it is assumed that pumps are to be run continuously. For the maximum performance with the minimum of repair time, engines for pump duty should be run at lower r.p.m. and less b.hp. output than was required for intermittent hoist duty. The b.m.e.p. is consequently lower.

Determination of hydraulic horsepower

$$\text{Hydraulic hp.} = \frac{\text{Gal. per min.} \times \text{discharge press., p.s.i.}}{1714}$$

$$\text{Net engine hp. input} = \frac{\text{Hyd. hp.}}{\text{Pump (mech.) effic.} \times \text{prime mover effic.}}$$

Assume prime mover efficiency 70 to 85%
Pump mechanical efficiency 75%
Pump volumetric efficiency 95%

Suppose we have a 7¾ in. by 18 in. power pump, using 5½-in. liners, running 55 strokes a minute, at a maximum discharge pressure of 1560 lb. per sq. in., and a volumetric capacity of 373 gal. a minute.

Then:

$$\text{Pump hydraulic hp.} = \frac{373 \times 1560}{1714}$$

$$= 340$$

$$\text{Engine input hp.} = \frac{340}{.75 \times .85}$$

$$= 535 \text{ considering pump effic. of } 85\%$$

It would seem, therefore, that to satisfy the hypothetical pumping condition specified in this instance, an engine with an input horsepower of 535 is required.

● **General considerations.** In additional to the mathematical and engineering considerations so far introduced, there are some incidentals that are important, and not the least of these is reduction of the fire hazard. The possibility of operating in a flammable or explosive gas-air mixture is never too remote in oil field service, and every precaution must be exercised to prevent the release of sparks, or the exposure of hot surfaces, that might cause a conflagration. Although diesel engines have lower exhaust temperatures than those fueled with gasoline, gas, or butane, it is still necessary to use some sort of spark-proofing, or water cooling of the exhaust manifold, together with spark arrestors, to achieve the maximum in safety practice. Lacking water cooling facilities to take care of the entire manifold, however, a covering of asbestos will at least give some measure of protection.

With other internal-combustion engines, the entire ignition and all its appurtenances should be spark-proofed. This includes the generator, magneto, distributor, spark plugs, wiring, etc., all of which should be enclosed in an explosion and fireproof system. But, it should be remembered that it is equally necessary to remove the fire hazards from other adjacent equipment, and that little is to be gained by spark-proofing the engine, and ignoring obvious hazards in nearby machines. Safe operation demands that *all* known hazards be eliminated wherever they may be, so that even V-belts and other accessories that have a tendency to build up static should be equipped with spark arrestors, or should be properly grounded.

In the selection of an engine for a drilling rig, the type of service to which it will be applied must be taken into account. A large, slow, heavy-duty drilling engine will certainly outlast a lightweight high-speed engine by a considerable margin, so that length of service is a potent factor in the ultimate choice. On the other hand, a heavy engine will be harder to move, more costly to operate (from a fuel consumption, not from a maintenance standpoint), and would, therefore, be quite unsuitable for a portable unit on wheels. The heavier unit would actually put out no more horsepower, but because of its ruggedness would require less servicing. Remembering that large skid drawworks require special moving facilities in any case, the selection of long life, slow-speed, heavy-duty engines for such units is proper. Coincidentally, lightweight, high-speed, engines must be used for portable units, because of space and weight limitations, in which highway regulations have a decided influence.

The ideal fuel, if fuel were the only consideration, is butane, since this product gives fine throttling performance, a clean running motor, no gum deposits, no sticky valves, no fouled spark plugs, and hence tends to lengthen the life of the engine. In addition it is frequently a distinct advantage that butane can be interchanged with natural gas. The disadvantages of butane are that it is highly explosive, must be carried in pressure vessels, and must have special type storage. Ordinarily, diesels are used on drilling rigs where butane or natural gas are not available. They have a naturally high efficiency, and per pound of fuel will deliver more energy than gas, gasoline, or butane engines. In regions where all types of fuel are available, and the operator is an oil company, this, however, is not too important.

It might be noted, in conclusion, that one major oil company has a 750 hp. radial aircraft engine on an experimental mount, driving a large drawworks. While this engine has not been tested in the field yet, it does appear to give promise of interesting developments. The use of war surplus aircraft engines would provide extreme horsepowers in lightweight portable drilling and servicing units at expenditure of very little weight. The service life of such engines however, might be quite short, and frequent servicing and part replacement necessary. Cooling of engines and transmissions also seems to pose a major problem.

The opinion of this author is that rather than experiment with surplus war aircraft engines, it would be better to concentrate on the development of a lightweight, medium-speed oil field engine, especially adapted for the type of service involved, and increase the ratio of horsepower to weight by substituting lighter materials, such as heat-treated steels and aluminum alloys, for those now being used. Some engine manufacturers are already showing an interest in this channel of research, and there is every likelihood that it will eventually become a general trend. ★★★

This scale was removed from a boiler to which unsoftened water was fed.

Soft water for the oil industry

By **FRANK H. LOVE,** *Managing Editor*

WATER is an all-important auxiliary in petroleum industry operations. In fact, without it or some substitute to fulfill its functions there could be no drilling of oil wells, refining of the crude oil into fuels, or transportation of petroleum and its products. Water, thus admittedly of great service and invaluable, can also be a source of operating trouble if not of the proper softness. Unfortunately all localities are not favored with a source of soft water. The mineral impurities in water, the calcium and magnesium salts that constitute the "hardness," form scale, sludge, and mud deposits in boilers, heat exchangers, cooling coils, piping and other equipment, thus lowering efficiency and resulting in increased maintenance costs.

EXCLUSIVE

The boiler is one example of the degree to which hard water can affect the operation of a piece of equipment. Regardless of its design and pressure, a boiler will operate efficiently only when properly conditioned water is fed to it. Scale deposited on drums and tubes of boilers reduces the transfer of heat to the boiler water. This results in bagging, blistering, and rupturing of the tubes, lowers operating efficiency, increases fuel cost, and necessitates delays, inconveniences, and expense of shutdowns for descaling, repairs, and replacements.

When unsoftened water is used, hardness impurities concentrate in the boiler and they, together with slugs of water, are carried over with the steam. The result is deposits in superheaters and turbines.

Operators are in agreement, also, that hard water scale and lime deposits on heat transfer surfaces are highly detrimental to the operating efficiency and life of cooling equipment. Such deposits interfere with the transfer of heat, lower the capacity of equipment, and often render it inoperative. These are a few examples of what hard water can do to petroleum industry equipment.

An effective method of softening water is by the use of zeolite. The action of zeolite is known as base exchange or ion exchange. When water containing calcium and magnesium comes in contact with the zeolite, the sodium in the zeolite replaces the calcium and magnesium in the water, and simultaneously the calcium and magnesium combine with the zeolite. In the exchange the calcium and magnesium hardness is removed and the water is made "zero-soft". The sodium is completely soluble at all temperatures and does not cause scale.

After the exchange capacity of the zeolite is exhausted, it is necessary that it be reconditioned to restore its original softening qualities. The first step in this process is back-washing. This is accomplished by reversing the flow of water through the zeolite bed. The upward flow carries out any dirt that may have accumulated on top of the bed. The zeolite is also loosened and graded during backwashing, preventing the possibility of the bed becoming packed or channeled. Assurance is thus had that salt will reach and regenerate each granule of zeolite properly in the "brining" operation that follows.

Hard water deposits scale inside piping, restricting flow of water and transfer of heat.

The second step in reconditioning is regeneration. A strong brine, which is common salt solution, is passed downward through the water softening equipment by means of a built-in pump. The exchange reaction that took place during softening is reversed and the sodium from the brine is put back into the zeolite. With the sodium restored, the zeolite regains its original ability to soften water. After the brining operation, regeneration is completed by allowing rinse water to flow downward through the softener to wash out the calcium, magnesium, and spent brine.

The nature of the zeolite softening process is such that it cannot undertreat or overtreat the water, if used in the proper equipment, because the method simply changes the hardness-forming elements in water to a form that will not produce scale.

The kind of zeolite used is of greatest importance. It is true that the best zeolite is ineffective in an improperly designed water softener, but it is also true that the best water softening equipment will be inefficient if a poor zeolite, or one of the wrong type, is used. Before installing water-softening equipment, therefore, a careful study should be made. The purpose for which the softened water is to be used should be analyzed, the mechanical requirements involved in setting up the water softening equipment should be considered, and the

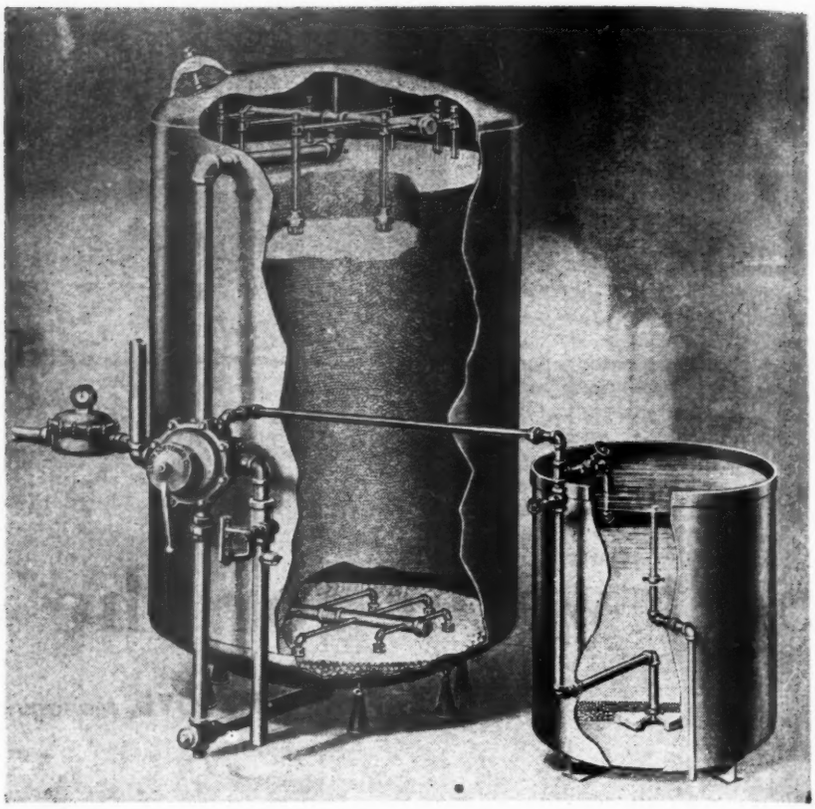
characteristics of the water to be softened should be determined. From this data the selection of the equipment and choice of the type of zeolite should be made.

The following are descriptions of the principal zeolites and the purposes for which each is most suitable.

Standard greensand zeolite is excellent for use in softening water of medium and low hardness. It is used where the demand for soft water is periodically heavy. Because of its high resistance to the chemical impurities in water, it can be used to soften almost any type of natural water, including the so-called aggressive or corrosive waters, which are low in hardness, low in silica, or low in pH value. It will not increase the silica content of the water. One of its properties is that of removing dissolved iron simultaneously with its softening action. This zeolite is capable of filtering small amounts of suspended matter from water. It is a durable mineral, which property protects it from wear and disintegration. It can be regenerated at low cost. The water-softening capacity is rated at 3000 to 3500 grains per cu. ft. It is dark green in color, weighs 90 lb. per cu. ft., and the granules are irregularly rounded in shape.

High capacity greensand zeolite can be used with any type of water, but is especially recommended for waters high in hardness, low in silica and pH value, or waters that contain iron. Its use is also recommended where large volumes of soft water are required between regenerations. It will not increase the silica content of the water.

This zeolite is specially processed to give approximately double the capacity of standard greensand zeolite. The processing gives each granule greater reacting surface with which to contact and soften more water. A special processing and stabilizing operation makes this zeolite even more resistant than standard greensand zeolite to waters that are low in alkalinity or pH value, low in silica, or of high temperature. Its capacity for removing impurities from water is even greater than that of standard greensand zeolite. It is greenish black in color, irregularly rounded in shape, and weighs 83 lb. per cu. ft. Its capacity is rated at 5000 to 5500 grains exchange per cu. ft., and it is capable of filtering small amounts of suspended matter from water. The granules are solid, hard, and durable. It is extremely long-lived and maintains its original effective high capacity, size, and shape.



Cross-sectional view of single-unit water softener with multiport valve control.

Synthetic zeolite is recommended for waters having a high silica content, a pH value in the neutral zone, and a low iron content. Its high capacity makes it particularly suitable for softening hard water that is relatively free from suspended matter.

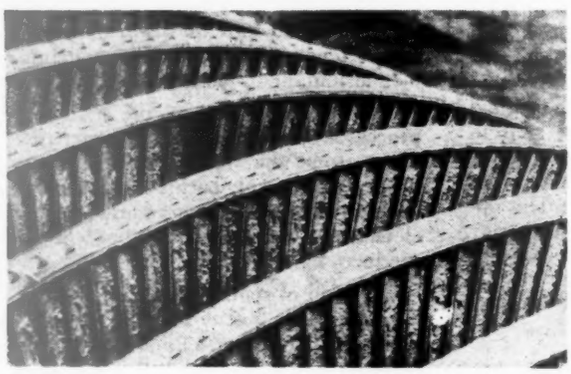
The capacity of this zeolite is rated at 10,000 to 11,500 grains exchange per cu. ft. In addition to its high capacity, it also permits higher softening flow rates.

This zeolite is a hydrous sodium alumino-silicate. It is a durable, tough material that has a high resistance to attrition loss. The large size of its granules permits high flow rates. The granules are white in color and angular in shape. A cubic foot weighs 50 lb.

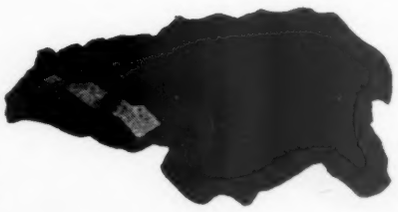
Resinous zeolite is a non-siliceous synthetic resin produced to give the highest exchange capacity. It can be used over a wide range of temperature and pH value. It has an exchange capacity of 15,000 grains per cu. ft., which makes it particularly suitable for water high in hardness. It is most suitable for use with clear waters that are low in pH value, high in iron, or high in temperature.

This zeolite may be regenerated either with salt or acid. It is black in color and angular in shape. A cubic foot weighs 50 lb.

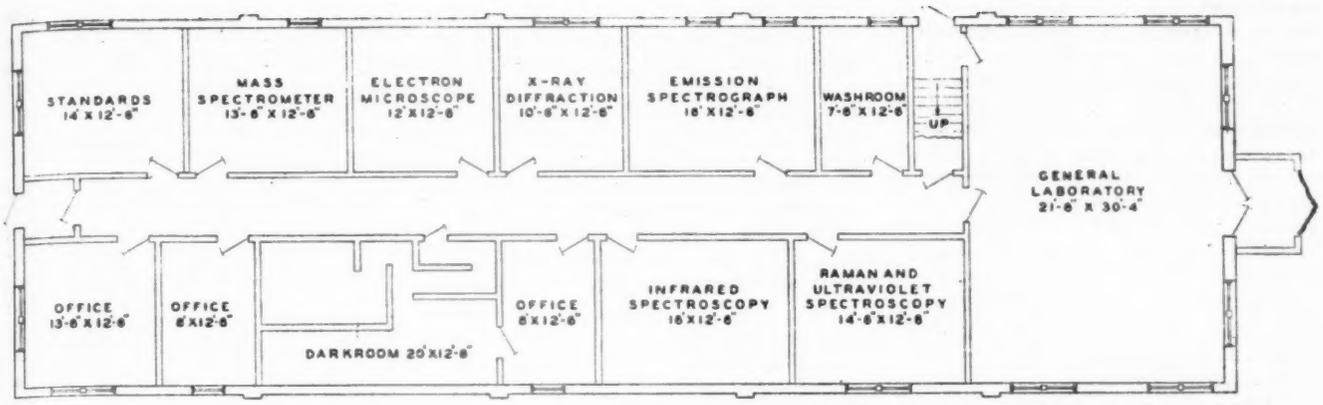
★ ★ ★



This scale deposit is in a steam turbine—the water was not properly conditioned.



Sludge formed by unsoftened water bakes on heating surfaces, lowering efficiency.



Physics laboratory building (32 ft. by 105 ft. by 13 ft. to eaves).

Physics research division broadens its activities

By **G. M. WEBB***
W. S. GALLAWAY
M. J. MURRAY
C. H. EHRHARDT
Universal Oil Products Company

PART 1

THE Physics Division of Universal Products Company has just moved into a new home. It is a functional building, designed in large part by the men who are to work in it. The new structure was built adjoining the outgrown previous quarters of the division on the 27-acre tract occupied by the company's research and development laboratories at Riverside, Illinois.

The move was made necessary by the widening scope and the increasing volume of the work of the division. The new building affords the needed space, equipment and conditions favorable for the varied research programs being carried on by the group.

The physics division had its beginning in 1939. Up to that time relatively little attention had been given to the possibilities of applying physical methods to the solution of chemical problems in the refining industry.

Catalysis at that time was of constantly growing importance, but knowledge of the properties of solid catalysts was limited. Consequently, the first task the division set for itself was a thorough study of the catalysts then in use, to determine the controlling factors with respect to catalyst life, activity, mechanical strength and utilization.

As the work progressed, the knowledge of existing catalysts has been increased and their efficiency has been improved. This is notably true for the nickel hydrogenation catalyst, the phosphoric acid polymerization catalyst, the chromia-alumina dehydrogenation catalyst, the silica-alumina and silica-magnesia cracking catalysts, and the molybdena-alumina hydroforming catalyst.

In addition, some new catalysts have been developed, perfected and commercialized, such as the metallic aluminum dehydrofluorination catalyst.

The work on catalysts was only the beginning. For several years the science of physics has been playing a role of increasing importance in hydrocarbon research. Various physical procedures have been developed and new apparatus has been brought out. Keeping pace with advances in physical research methods, this company has adopted such of the new techniques as could be profitably applied in the oil industry. The field of activities has been extended to cover physical investigation of petroleum, gases and other materials as well as catalysts.

The physics division today has three primary functions:

1. *Improvement of known catalysts and a study of their fundamental properties.*
2. *The identification and quantitative analysis of gaseous and liquid hydrocarbons and the products made from them.*
3. *General physico-chemical studies of interest to the petroleum industry.*

● **Description of building.** The new home of the physics division was designed in line with modern ideas for such buildings. It is a gable-roofed structure, 105 feet long by 32 feet wide, and is 13 feet to the eaves. Water, steam, air and vacuum lines, and 110 to 220 volt electric power are brought into the building in a trench, led through a wall to the attic and from thence distributed to the various rooms by carrying the lines down through the partition walls between the studs. These service lines are easily accessible for maintenance and repairs by removing steel plates that are fastened to light angles attached to the studs. The service lines in each room are supported on racks fastened to the wall and are concealed by the benches and tables, all of which can be moved when necessary to permit work on the service lines.

Individual power panels are provided for each room where necessary. The panels are installed in hall partition walls and are of the flush type with the doors opening into the hall. The main power panel is situated in the large room used as a general laboratory. With this arrangement, if the power should fail in one room the others are unaffected.

The air in the physics building is filtered, warmed (or cooled) and humidified by heating and air conditioning equipment installed in the attic. In order to avoid vibration in the building, the equipment is supported on pipe columns that are situated in the dead space in the partition walls, free from contact with the walls. These columns are set on concrete spread footings and are insulated from the floor by cork expansion joints. Air conditioning and the anti-vibration measures are necessary to assure accuracy in the operation of the extremely sensitive apparatus.

The accompanying floor plan shows how the interior is divided. Space has been reserved for enlargement of the building when increasing scope and volume of work make it necessary.

*Dr. Webb is director of the Physics Division, Universal Oil Products Company, and the others are his associates.

● **Description and use of special equipment.** The equipment housed in the new building includes ultraviolet, visible, infrared and Raman spectroscopic apparatuses, a mass spectrometer, X-ray and electron diffraction units, an electron microscope, microphotometers, surface area measuring equipment and a wide variety of physical and electrical apparatuses for determining various properties of oils and catalysts, such as dielectric constants, porosities, freezing points and others.

In the following sections, some of these instruments are described, and the kind of information that can be obtained with them is pointed out.

Ultraviolet spectrophotometry

● **Synopsis.** *When ultraviolet light is passed through a sample of a chemical compound, certain wave lengths of light are absorbed more than others. This absorption spectrum, which may be obtained with an ultraviolet spectrophotometer, is different for each compound. This fact is made wide use of in the petroleum industry, and application of ultraviolet spectrophotometric methods has resulted in improved methods for making many types of analyses. For example, these methods are used in controlling the operation of hydroforming units for the maximum production of toluene and in the control of plants, making raw materials for synthetic rubber manufacure, such as butadiene and styrene.*

The instrument employed is a Beckman quartz spectrophotometer, Model DU.

For work in the ultraviolet a hydrogen lamp is the source of continuous radiation, and for studies in the visible and near ultraviolet this may be replaced by a Mazda lamp.

Light from the lamp is made to pass through a slit into the spectrometer where it is dispersed by a quartz prism. This dispersion separates the light so that light of a narrow band of wave lengths emerges from the exit slit of the spectrometer at one time. By altering the position of the prism, light of any desired wave length can be made to pass through the exit slit.

As the narrow band emerges from the slit it is allowed for the usual procedure to pass through a 1 cm. cell containing pure solvent. The intensity of the emergent beam is measured on a photocell and the instrument is balanced electrically for this condition. The solvent cell is then removed and in its place is inserted the sample dissolved in the same solvent as was used in balancing the instrument. If there is a substance in the solvent that is excited by light of the particular wave length then passing through the slit some of the light will be absorbed and that which falls on the cell will have a lower intensity than that passing through the standard cell. This causes the instrument to be out of balance electrically. When balanced again the dial involved in the process indicates the per cent transmission of the unknown as compared to the pure solvent. Thus, if only one tenth of the light gets through the solution the transmission is said to be 10 per cent.

By turning the prism the spectrum is moved across the slit and the emergent beam has a different wave length. At this new wave length the instrument is again balanced for the solvent in the one cell and the solution in the second cell. The dial that turns the prism is calibrated in wave length, hence a plot of wave length against per cent transmission may be made. This plot is called the absorption spectrum of the compound.

Ultraviolet radiation contains sufficient energy to bring about deep-seated transition processes, i.e., electronic transitions (upon which are imposed vibrational and rotational changes in the molecule). The shortest wave lengths usually used with the Beckman instrument in practice are about 2150 A°* as it becomes increasingly difficult to obtain solvents pure enough for shorter wave lengths.

There are many, many compounds that show practically no response to ultraviolet waves of 2150 A° or longer. For example, the electrons of saturated hydrocarbons are so tightly held that they are not disturbed by ultraviolet radiation of this amount of energy passing through their vicinity. The situation is somewhat different with regard to olefins. At the short wave lengths around 2150 A° there is some response, i.e., a slight amount of absorption. In the case of conjugated diolefins as butadiene, isoprene, etc., the electronic system, already in a resonance state, responds to light of wave lengths readily available and measurable in the quartz spectrophotometer. Other resonating systems easily excited are, for example, benzene rings, carbonyl groups, and the nitro groups. Carbonyl groups absorb strongly near 2700 A° even without being conjugated. Benzene itself has a number of strong bands easily resolvable on this instrument between 2400 and 2650 A°. In toluene the absorption is shifted a little to the longer wave lengths and one of the principal bands is near 2680 A°. Di-substituted benzene derivatives absorb strongly and have some bands longer than 2700 A°. It is easy to distinguish naphthalene, α-methylnaphthalene and β-methylnaphthalene from each other by sharp bands between 3000 and 3200 A°. Butadiene has exceedingly powerful absorption near 2150 and isoprene a similar band at 2230 A°. As substitution on the C = C — C = C increases, the wave length of the band shifts to the red. A similar phenomenon is noted in the C = C — C = O system.

The ultraviolet spectrophotometer serves three main purposes: (1) Quantitative determinations, (2) qualitative identifications, and (3) research.

In quantitative work a solution of a carefully purified sample, for example, benzene, is quantitatively made up in a purified solvent such as alcohol, hexane, or isooctane. The optical densities at the peaks of the compound's absorption are measured. Since the optical density depends upon the concentration of the benzene in the solution it is necessary to choose some standard concentration using also a standard thickness cell. In the Beckman instrument the cell is usually 1 cm. thick. The standard concentration is often taken as 1 g. per liter of solution. The specific extinction coefficient is then the optical density that should be observed for a solution having 1 g. of the pure compound in 1 liter of solution when observed in a cell 1 cm.

*The symbol A° refers to the A°ngstrom unit., which is a measure of length. There are 100 million A°ngstrom units in one centimeter.

Infrared absorption spectrometer.

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thick. Hence, in a sample containing an unknown quantity of benzene and no other compound having appreciable absorption near 2600 A°, it is possible to make a very rapid and accurate quantitative determination of the hydrocarbon. A solution of the sample is made up in isooctane. Its specific extinction coefficient is determined by dividing the observed optical density by the concentration of the sample in grams per liter. To obtain the per cent benzene by weight in the sample:

$$\frac{\text{Specific extinction coeff. for sample}}{\text{Specific extinction coeff. for benzene}} \times 100$$

Likewise, quantitative analyses can be run for other compounds having absorption bands in the ultraviolet or visible regions of the spectrum when no other compound present in the sample has absorption.

If two absorbers are present such as benzene and toluene the problem is somewhat more complex, but the analysis is quite reliable and easily and rapidly made. The observed optical density at a given wave length is made up of absorption due both to benzene and to toluene. By selecting two wave lengths preferably at positions where for one benzene has a strong band and for the other toluene is the main absorber, the composition of the sample can be worked out either by simultaneous equations or by successive approximations.

This same principle has been applied successfully to the C_8 aromatics, where four different wave lengths and four equations are required.

Nor is the quantitative work with the ultraviolet spectrophotometer limited to those compounds in themselves having a chromophoric (light absorbing) group. A reaction may be carried out whereby a chromophore is introduced chemically and quantity of derivative measured.

For qualitative and research work the absorption spectrum of the sample is determined. From a knowledge of the chemical possibilities and the known spectra of compounds many useful conclusions as to the presence of certain compounds or types of compounds can be drawn.

The versatility for example may be extended in another way so that inorganic ions, as for example, magnesium, may be analyzed quickly and accurately. 8-hydroxyquinoline has very powerful absorption in the ultraviolet, one band of which is near 3300 A°. The amount of this reagent present in a solution can be measured accurately on the spectrophotometer. To determine magnesium one adds the unknown sample to a solution of 8-hydroxyquinoline and allows the reaction to proceed for a short time. The solution is filtered and the optical density at 3300 A° is measured. From a plot of optical density *vs.* milligrams of magnesium the amount of magnesium in the sample can be read off directly. This method of analysis has been helpful in developing rapid control methods for the manufacture of silica-magnesia cracking catalysts.

The ultraviolet instrument is quite versatile; in addition to examination of organic compounds by their ultraviolet absorption spectra, the instrument can, with slight modifications, be used for a host of other purposes, for example, many inorganic analyses and also for color determinations, glossiness, etc.

Infrared spectroscopy

● **Synopsis.** *The applications of infrared spectroscopy are based on the important facts that no two hydrocarbons exhibit the same absorption pattern and that the pattern obtained for a mixture is simply the sum of those of the components. Thus, it has been possible with the infrared spectrometer to obtain reliable quantitative and qualitative analyses that were extremely difficult or time consuming by other methods. Among these, to mention only two, are the studies of the products of alkylation and isomerization plants which led to increased production of better aviation gasoline.*

The infrared region of the light spectrum is that portion which lies between the longest wave lengths of light visible to the eye and the shortest radio waves. For most applications, only the smaller wave length interval of 2 to 15 microns* is used. For comparison, the ultraviolet region is from 0.2 to 0.4 microns while the eye is sensitive only to light of wave lengths between 0.4 to 0.7 microns.

The spectrometer used for the infrared studies is of the large or research type custom built for UOP by the Gaertner Scientific Company. It is a Littrow type instrument. The source of light is a Nernst glower, a ceramic filament electrically heated to a temperature of 3800° F. The light from this source is focused on the entrance slit of the spectrometer, passes through, and then falls on an off-axis parabolic mirror so set that the reflected beam of light is made parallel and falls on the face of a large rock salt prism. This prism was cut from a single crystal of rock salt weighing over 20 lb. After passing through the prism, the light is reflected back over nearly the same path by a flat movable mirror called the Littrow mirror. Thus both the prism and the parabolic mirror are used twice. The latter causes the return beam to be focused on a second or exit slit after which, by use of an ellipsoidal mirror, the light is brought to bear on an extremely sensitive thermocouple that measures the intensity of the light by means of its heating effect. The couple is capable of detecting temperature changes of the order of a few one-hundred thousandths of a degree. Since the prism refracts or bends light of different wave lengths by different amounts, the setting of the Littrow mirror determines the wave length of the light that reaches the thermocouple.

The instrument may be operated in either of two ways. The first is to measure the thermocouple response at a given wave length setting with and without the sample in the beam. As these readings represent the intensity of the light transmitted under these conditions, the ratio gives the per cent transmission of the sample. The other method is to drive by means of a small motor both the wave length control and a recording drum. The result is a continuous recording of the intensity of the light transmitted as a function of the wave length. A comparision of the records for a filled and empty cell yields the per cent transmission at any wave length desired.

The cells in which the samples are contained are placed in front of the entrance slit of the spectrometer. For gases and liquids, they are made from two rock salt plates for windows with a suitable spacer between. Gas samples are usually studied in cells about 6 inches thick under pressures of approximately ½ atmosphere, whereas for liquids, the space between the plates is only 1/250 of an inch. Solids may be handled in thin sheets, in solution or suspension in some liquid, and as a powder dusted on a plate. Rock salt is usually chosen as a window material, for it is the most conveniently handled substance that is transparent throughout the desired wave length interval. Such materials as quartz and glass are opaque here. A polished salt plate appears to the eye to be as transparent as the finest optical glass.

The interest in the infrared portion of the electromagnetic spectrum lies in the fact that the frequencies of the light in this interval are of the same size as the vibrational frequencies of molecules. When infrared rays of a given wave length are allowed to fall on a sample and if the light waves have exactly the same frequency as some natural vibration of the molecules, then the light of this wave length will be absorbed and the atoms of the molecule will start to oscillate. The intensity of the absorption depends on the ease with which this particular mode of vibration can be excited. If the light frequency is not the same as any natural vibration of the molecule, then the rays will pass on, undisturbed by the presence of the sample. Thus a plot of the intensity of the light transmitted through a sample (or per cent transmission) versus wave length will show a series of dips of different depths. This plot is called the spectrum of the sample. A little consideration will immediately bring out two very important facts. The first is that two different compounds cannot have the same spectrum since the slightest change in composition or geometrical arrangement of the atoms of the molecule will change the vibration pattern. The second is that compounds having a common structural feature (such as the aromatics which all contain a benzene ring) will show one or more similar absorptions indicative of the common structure.

The uniqueness of the infrared spectrum of a given hydrocarbon is the basis for much of the work done with this instrument. A direct comparison of the spectrum of the sample with those of pure materials will show what compounds are present or absent by the corresponding presence or absence of the

*The micron is another measure of length, commonly used in spectroscopic work; there are 10,000 microns in one centimeter.

characteristic absorption patterns. Quantitative determinations follow immediately since the intensities of the absorptions are proportional to the concentrations. This positive and accurate method of analysis has seen intensive use in the analysis of alkylates, hydropolymers, and other components of aviation gasoline, analyses that, without infrared, were extremely time-consuming and of questionable reliability if possible at all.

The diversity of application is tremendous, from straight-forward routine analyses of mixtures of butanes and of alkylate to the problem of following chemical reactions. In the latter case, not only are the final products determined but also one studies the intermediate products to learn through what steps the reaction took place. An example of this latter problem was the study of oxidation of paint films. In one type of paint, it was found that the vehicle first oxidized and then the oxidation product reacted with the pigment. Knowing this, it was relatively simple to stabilize this type of paint. Chemical methods had failed because they required that the samples be acted upon by strong reagents to get them in solution and thus changed the nature of the sample. The fact that infrared analyses do not in any way change the samples was of importance here, especially since the same sample could be studied during oxidation.

The applications of infrared are not limited to those problems in which the components are actually identified. In many cases some new compound or unusual product results from the work of the research chemist. His problem is then to find out what type of material he has—a ketone, an aromatic, an alcohol, or what? Here the fact that similar type compounds have certain common obsorptions is brought into play. The kind of compound, such as those already mentioned, the presence and type of branching, the location of double bonds to mention a few items, can be determined.

Not being satisfied with solving these types of problems, the infrared spectroscopist has done such odd things as measure the index of refraction for visible light and the particle size of extremely fine powders by means of the infrared absorption pattern.

Raman spectroscopy

● **Synopsis.** *The Raman effect, though obtained in an entirely different manner than the infrared absorption spectrum, is considered to be a complement to infrared absorption work. As in infrared absorption, each compound exhibits its spectrum, which is different from that of every other compound. The Raman effect is mainly useful in qualitative identification and semi-quantitative analyses of organic compounds in unknown mixtures. It can be employed with aqueous solutions as well as with anhydrous mixtures.*

In order to obtain Raman spectra it is only necessary to pass light from a mercury lamp (not the high temperature, high pressure type) into a sample and observe the light scattered by the sample for any direction normal to the incident beam by use of a spectrograph. The utility of the spectra and the speed with which they are obtained, however, depends on a number of factors.

As each quantum of radiation entering the sample has a chance of exciting the molecule into rotational-vibrational states, above that in which the molecule is found, the spectrum obtained would be very complex unless nearly monochromatic radiation is used. No ideal source of such radiation is known, but low pressure, low temperature mercury lamps come the nearest to producing the desired result. By use of proper light filters placed between the lamp and the sample all other light than 4358 A° is so weakened that the spectrum is very nearly that excited only by this one wave length.

The sample is contained in a scattering tube so designed that "false light" entering the spectrograph is reduced to a minimum. The usual tube looks somewhat like an ordinary glass adapter used in distillation but has a plane glass plate sealed to the large end and the curved part is blackened.

Light from within the sample is collected in the slit of the spectrograph by a condensing lens.

Raman spectra can be obtained by use of most any kind of spectrograph but in order to be useful the instrument must have good light-gathering characteristics, i.e., high speed. At the same time it is desirable to retain fair dispersion and good resolution. The instrument ordered for use in the new laboratory is of f/3.5 lens aperture and has a dispersion of approx. 20 A°/mm. near 4500 A°. It has two large, liquid filled prisms. Rigid temperature control is being built into the instrument.

When a light quantum, for example, the blue 4358 A° mercury light, illuminates a transparent sample one of several phenomena may occur. The quantum may simply be transmitted by the liquid as, in truth, most of them are, hence the "transparent" material. Some of the quanta may, on the other hand, react with molecules of the sample. In this reaction there are several possible results. They are listed in decreasing order of occurrence.

1. A re-emission of the light beam (or quantum) with the same wave length, or frequency of vibration as before. The direction has, however, been changed. In other words the light is scattered. This is the familiar Rayleigh scattering and is responsible for the blue of the sky. Such quanta appear on Raman spectra as the undisplaced exciting line, or lines if several wave lengths are used.

2. During the interaction of the quantum and a molecule the quantum may give a discrete portion of its energy, which is the amount necessary to set up a rotation-vibration motion within the molecule. The quantum emerges from this process with lower energy than before. All quanta that started up a certain motion in the molecule would lose the same amount of energy, i.e., appear in the Raman spectrum at a certain place (as a band or line). The difference between the frequency of the light at the beginning and frequency after the encounter is called the Raman frequency or Raman shift. This shift is the counterpart of the absolute frequency of the absorption bands in the infrared. It is often found to bear a direct relation with the difference in frequencies of ultraviolet absorption bands.

The magnitude of the Raman shift or Raman frequency depends on a number of factors, chief of which are:

a. The strength of the chemical bond between the atoms most thoroughly involved in the vibration. Although each vibration really involves the whole molecule certain approximations allow one to assign, for example, lines having frequencies near 2200 vibrations per centimeter in acetylenes, to the stretching of the $-C \equiv C-$ linkage. At lower frequencies, near 1600 vibrations per centimeter, will be found the vibration of the weaker $C = C$ bond. The single carbon-carbon bond has a frequency near 1000 vibrations per centimeter.

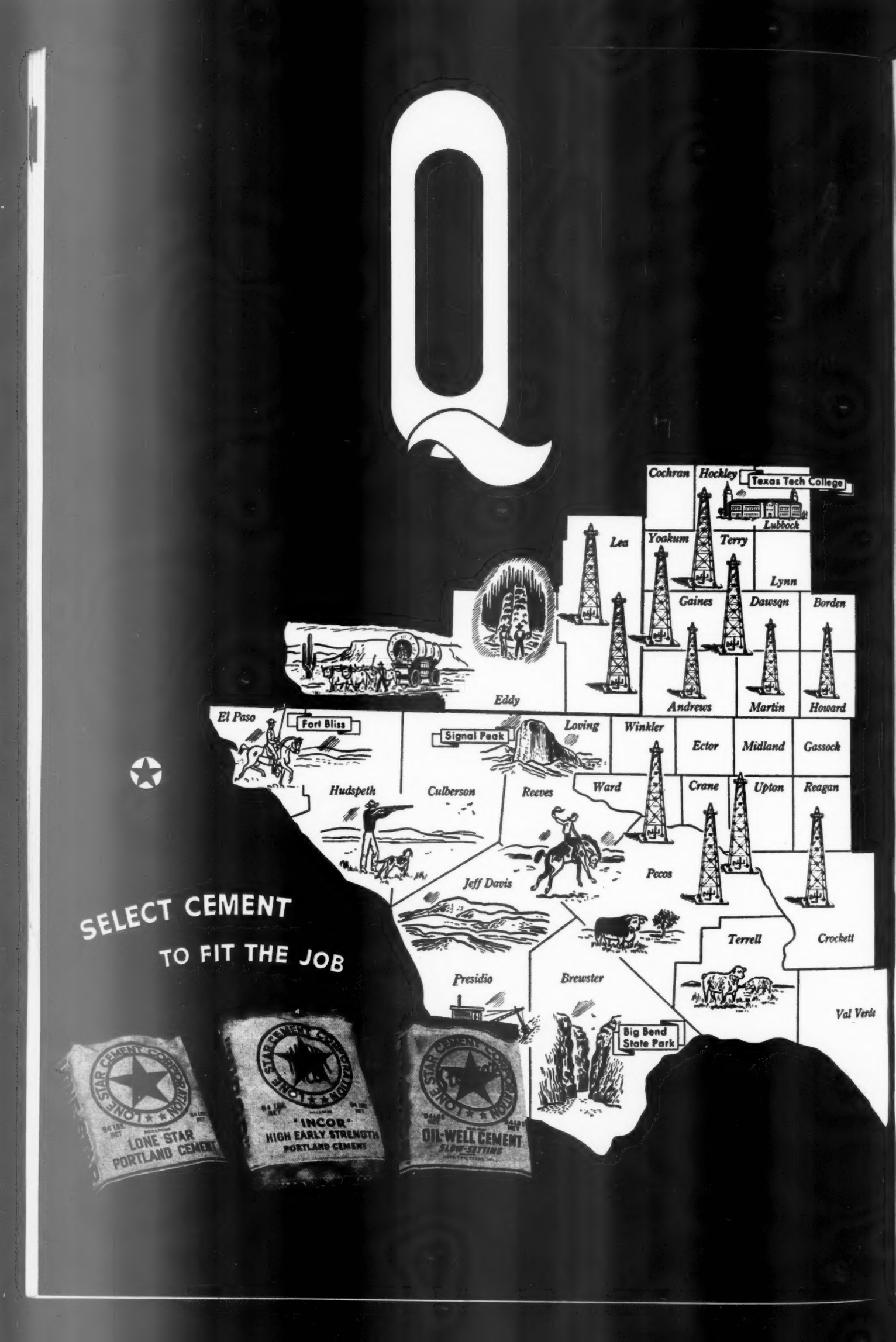
b. The mass of the vibrating atoms. The $C \longleftrightarrow H$ (stretching) frequency is near 3000 vibrations per centimeter, whereas the $C \longleftrightarrow D$ is near 2100 vibrations per centimeter.

c. The type of vibration, i.e., whether the vibration is one involving stretching or bending of the valence bond.

3. The third type of interaction of a quantum is with a molecule already in a rotation-vibration above the ground state. From such a molecule the quantum may actually gain energy and emerge from the collision with a higher frequency than at the start. These would appear as Raman lines (anti-Stoke's) on the violet side of the exciting line.

Aside from the fact that there are so-called selection rules that permit certain vibrations to be active or inactive in the Raman or infrared, the spectrum obtained on the same sample tells the same story as to the types of vibration, strength of binding, etc. It could be asked, then, why should both instruments be available? First, there are the selection rules that make infrared and Raman data to a large extent complementary. Those bands that are strongest in infrared are often weakest in the Raman and vice versa. Solutions containing water can readily be examined by the Raman effect but are untouchable by infrared. Each Raman spectrum covers the complete range and many low frequency bands, hard or almost impossible to get on infrared, are readily accessible by Raman techniques. Finally, the library of Raman data is far more comprehensive and readily available than similar information for the infrared. Infrared spectroscopists have been limited by the instruments to reporting only short and sometimes quite unimportant regions of the spectra, whereas Raman data usually include at least the major bands throughout the spectrum. These considerations make the Raman method of special use in the detection of specific compounds or types of compounds.

The conclusion of Dr. Webb's article will appear soon.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Observations on the chemical demulsification of crude oil

By **LOUIS T. MONSON**

Tretolite Company of California

EXCLUSIVE

THE purpose of this presentation is to call attention to certain phases of the use of chemical demulsifiers or dehydrating agents in connection with the production of crude oil, and especially to more novel or lesser-known applications of such reagents. It is proposed to present subsequently, in a companion article, some information on the use of such reagents in the laboratory examination of crude oil.

Naturally occurring crude oil emulsions have engaged the attention of the American petroleum industry for more than half a century; and procedures for their resolution have long been established on an operating basis. Nevertheless, many of the methods and procedures employed today are only improvements of pioneer methods that were first applied within the memories of persons still actively employed in this field of endeavor. Therefore, while basic scientific facts have been and are being discovered and used in an effort to generalize and formalize the emulsion resolution art, it still remains largely an art rather than a science. Because it is an art, its procedures are inclined to be chiefly empirical or "rule of thumb," rather than calculated or devised from proven formulas.

Because it is a young art, as arts go, its procedures are still changing and improving. It is therefore desirable at intervals to review the changes in techniques and the improvements that have passed or are passing from tentative to established acceptance. Newly devised techniques naturally deserve attention, so that latest developments can be taken advantage of as promptly as possible.

Some of the following material will be well-understood by those who practice emulsion-breaking as their daily work. Because the author's experience has been acquired mostly in California, the general approach and some of the examples may unconsciously reflect that fact. Recognizing these limitations, however, it is proposed to set out certain phases of the business of resolving water-in-oil emulsions that have not received widespread attention to date.

It is expected that the problem of resolving oil-in-water emulsions will be discussed in a subsequent article. That is a field of growing importance, which is, however, entirely distinct from the problem of dehydrating wet crude oil.

● **Improvement of reagents.** When crude oil emulsions were first resolved chemically on a commercial scale, it was not uncommon to require a barrel of demulsifier to recover 500 bbl. of crude oil that would meet the liberal pipe line specifications of that pre-1920 period. That is not the whole story, of course. Those early reagents, copperas, common soap, washing powders, etc., frequently resolved the emulsion only partially, and left an appreciable intermediate sludge layer requiring re-processing or discarding. Early patents clearly show such intermediate layers in their drawings; they were evidently expected to occur.

As technical advances were made, oil recovery constantly rose, until today it is common to recover about 10,000 bbl. of crude per barrel of demulsifier. It is not infrequent today to find installations showing recoveries of as much as 30,000 or 40,000 or even 50,000 bbl. of clean oil for each barrel of chemical consumed. Such above-average recoveries are found in areas where the emulsions are more susceptible to chemical demulsification, and where adequate treating plants have been installed. Peak performance must never be expected of junk plants, even in such responsive areas.

A number of improvements in technology have been required to accomplish this advance. Principally, it represents a constant improvement in chemical reagents. A large number of chemicals have been compounded for resolving emulsions, until the manufacture of demulsifying agents has become in a sense a custom business, where reagents are tailored to do a specific job better than any other reagent in existence.

The problem is no longer one of obtaining marginal commercial results at any cost, as opposed to complete failure to resolve the emulsion. Rather, it is a problem of obtaining the best or optimum result, although the specifications may have been tightened repeatedly since the early days, and even marginally acceptable results have consequently been made more difficult to obtain.

For example, many of the early reagents were water-soluble or water-dispersible, and were used in fresh, soft water. But fresh, soft water is difficult to come by, in many oil fields. So, over the years, reagents have come to be introduced in undiluted form; and the reagents have been so compounded as to make this possible. Naturally, the original solid reagents have long since been displaced by liquid reagents; and modern reagents are generally so prepared as to be satisfactory under extreme conditions of use, irrespective of whether such use occurs in very warm or very cold regions.

Several examples of recent refinements in the art of treating cut oil will illustrate advances that have been made in compounding demulsifying agents.

In one field, original development work called for batch-treating the emulsions produced, using tanks with heating coils, because of the high viscosity and low API gravity of the oil. Several continuous-flow treating plants were eventually installed by one producer, however. When the reagent then in use elsewhere in that field was applied to such continuous-flow plants, it was found that, although clean oil could be recovered, the water did not separate rapidly enough to be removed from the oil in the wash tanks, as desired. Instead, the water separated subsequently, in the stock tanks. A reagent was thereupon developed that satisfactorily dropped the water in the wash tanks, so that only clean oil overflowed from them into the stock tanks. Incidentally, this reagent was not so effective in some of the batch-treating plants as was the reagent originally used on all.

In another field, again producing low-

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Louis T. Monson

gravity, high-viscosity oil, batch-treating had always been practiced, because all efforts to use continuous-treating systems, employing wash or flow tanks, had failed. The extremely heavy oil simply picked up any water placed over the heating coils in such tanks and carried it in entrained form to the stock tanks. Development of a fast-acting reagent permitted the continuous-treating system to be operated satisfactorily. A number of operating benefits were thereupon obtained, of the kind that have caused continuous-flow treating systems to become generally preferred over batch treating systems.

These examples illustrate another fact: since the inception of the use of chemicals for resolving crude oil emulsions, the burden of solving operating problems has continuously been placed on the reagent. In other words, difficulties experienced in the operation of a treating plant have commonly been overcome by the development of a new and superior reagent, rather than by the design of some broadly novel piece of apparatus or mechanical equipment.

As a consequence of this attitude of the industry, the chemical dehydration process is usually practiced by using the same elementary mechanical plants as were used a generation ago. In fact, some modern plants are even less complex, mechanically, because the improvement of chemical reagents has often made unnecessary the use of heat, "hay tanks," or some of the other "crutches" that were required at that earlier date, to assist the less effective reagents then in use.

● **Improvements in field practices.** Along with improvement in reagent formulation have come many improvements in field apparatus and technique. Reagents were at first introduced into the emulsion in haphazard fashion; but it is rare today to see chemical being introduced into a tank of emulsion from a bucket with a nail hole in its bottom. Even the "boll-weevils" or "lubricators" that came into use along with the first liquid reagents have for the most part become obsolete. It is simply not possible to introduce reagent at a regular rate through a gravity-operated dropping device, when temperature changes of appreciable magnitude occur within 24 hr. intervals; and regularity of reagent introduction is the first requisite for satisfactory, economical operation of the chemical demulsification process.

The modern chemical proportioning apparatus is specifically designed for its job. It is positive-acting, and is a decided improvement over the positive-displacement engine lubricators that were used for a time after the shortcomings of the drop-feed devices had become apparent. For the most part, pumping wells supply, from their walking beams, the motion needed for actuating the pump; but electrically-driven and gas-driven proportioning pumps are in very general use. The gas-driven devices are probably the newest types in this art, and have proved invaluable at locations where no source of motion or electricity is available.

Egyptian refinery

A new petroleum refinery is being planned by the Egyptian government. The proposed unit should have a capacity of 400 tons per day. It will be situated on the same plot as the government's existing Suez refinery, which handles about 200 tons daily. The present refinery will be left intact, so that, if necessary, the two plants could process a total of 600 tons daily.

Modern settling tanks, sand traps or tanks, liquid level controls, and flow systems all contribute to the present high level of performance. They represent steady development over the years. In areas where large potential production is known to exist, plans for the systematic treatment of emulsion are usually completed before the field becomes wet.

● **Balance of economic factors.** As the basic principles of chemical dehydration became established, it was natural that refinements of thought and action should come into use. For example, because the selling price of the demulsifying chemicals is appreciably higher than that of most petroleum products, it was natural that frugality should be generally practiced in the use of such chemicals. In some cases, this meant the use of higher treating temperatures—which in turn meant a larger consumption of heating gas. As the cost of gas rose with depletion of the field, this item alone sometimes became appreciable in importance.

Furthermore, there was another item of expense in the use of heat that, although frequently hidden, was much more important: the gravity and volume losses that result from the application of heat to oil. These losses sometimes amount to several times the cost of chemical, and yet are tolerated because they are either hidden and unrecognized or are accepted as unavoidable.

Costs of gravity losses are quickly estimable, because a loss of 1 deg. API usually results in an oil price penalty of from 2 cents to 5 cents a barrel. Even in areas where gravity losses are immaterial because of a flat posted price for oil, they are symptoms of volume losses that cannot be ignored. It is sometimes not realized that a gravity loss is always accompanied by a simultaneous loss in volume.

A number of writers have estimated this loss in volume to be 2.5 per cent for 1 deg. API gravity loss, for Mid-Continent oils. It has been stated, however, that this loss may be as high as 4 per cent for 1 deg. API loss on some 38-42 deg. API oils. One investigator who worked on California crudes reported volume losses of between 2.2 per cent and 3.4 per cent for 1 deg. API loss, in selected crudes from that state.

Assume that an Oklahoma crude of 40 deg. API gravity shows a 3 per cent volumetric loss for each 1 deg. API gravity loss. Assume that, to recover 100 bbl. of this crude from its emulsion, ½ gal. of chemical is required if the temperature is 100°F.; but that only ¼ gal. is needed if the treating temperature is raised to 150°F. The chemical saving at the higher temperature is about 50 cents (since chemical costs about $2.00 a gallon); but the gravity loss is 2 cents a barrel, and the volumetric loss is 3 bbl. of oil in 100. If the oil is worth $1.60 a barrel, this loss is $4.80 a hundred barrels; and the total loss incurred by treating at 150°F. is therefore $6.80. Since the saving in chemical is only 50 cents the net loss from treating at the higher temperature is over 6 cents a barrel.

By considering all cost factors and obtaining a proper balance between them, it has sometimes been found that a slight increase in chemical consumption results in a gain of as much as a point in gravity or a saving in volume of 1 or 2 per cent or more. For example, if an oil is 40 deg. API and contains 1 per cent of water having a density of 1.05, removal of that water will raise the gravity of the oil by 0.5 deg. API.

The higher the gravity of the oil and the greater the density of the water, the greater is this increase in oil gravity to be obtained by removal of the water.* In heavy-oil areas, gravity-price brackets may be broader, and less interest may attach to fractional increases in oil gravity. Also, the waters may be fresher and of lower density, and hence may exert less effect on oil gravity. Yet it is also true that such heavier oils usually carry more residual water, and the removal of such larger water contents reflects itself in greater effects on oil gravity. For example, a 20 deg. API oil, carrying 3 per cent of water of density 1.02, would become a 20.4 deg. oil if this water were removed.

It is apparent that a producer selling his oil 0.1 or 0.2 deg. below the minimum gravity of the next higher price bracket can afford to spend a major fraction of that price differential—which may be from 2 cents to 5 cents a barrel—if he can raise his oil gravity to that minimum level.

In the case of fields producing waxy high-gravity oils, use of a minimum proportion of chemical may produce pipeline oil; but it may also result in the gradual deposition of waxy tank bottoms, because a clean "break" has not been obtained. A slight increase in chemical feed may completely resolve the emulsion, eliminate tank bottom deposition, and obviate tank cleaning costs.

The foregoing examples illustrate the fact that chemical cost is only one of a number of factors involved in the economic evaluation of chemical dehydra-

*A chart showing the improvement in oil gravity obtainable by removing different percentages of water from crude oil may be procured from the author without obligation by addressing him at 5515 Telegraph Road, Los Angeles 22, California.

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tion processes; and that, while it is a very tangible and readily estimable cost factor, other and possibly hidden or intangible cost factors should not be overlooked. No one should use any more chemical reagent than he needs to resolve his emulsion efficiently; but use of increased chemical feed rates should not be forbidden simply because of the cost of reagent, per gallon.

● **Chemical injection points.** To obtain optimum results, the proper chemical must be applied at the proper point in the treating system. Although this is a simple and obvious statement, selection of such most favorable point of injection is sometimes extremely difficult. Where a well is flowing through a choke or flow bean, reagent may be introduced on the high-pressure or the low-pressure side of this choke, or it may be introduced after the trap, where a further pressure reduction may have taken place.

In the case of some waxy oils, such pressure drops are accompanied by temperature reductions sufficient to change the state of the wax component of the oil. In one instance, it was found that either of two reagents could be shown to be preferable to treat the emulsion produced from the well. One reagent was more effective when used before the choke; the other was more effective when used after the choke. Experienced treating men can anticipate problems like this and can solve them in a short time, because their experience enables them to make reasonably good predictions from a survey of the producing property. Even they are sometimes forced to experiment, however, to reach a final decision.

It will be apparent from the foregoing that the technology of resolving petroleum emulsions by means of chemical reagents has become a highly specialized art, wherein experience and specific training are paramount in personnel requirements. It is indicative of the level of such experience and ability, that there were no interruptions in the production of crude oil during the recent war years because of any snarls in the dehydration of the crude. One of the most critical potential bottlenecks in fueling the engines of war never materialized.

● **Changes in pipe line specifications.** Crude oil emulsions of the "cut oil" type contain as much as 90 per cent water as produced, distributed as droplets throughout a continuous body of oil. Pipe line specifications vary; but in general crude oil requires some corrective treatment if water and other impurities exceed 3 per cent. In some instances, pipe line limits are as low as 0.1 per cent. If oil exceeds the specified limits, it cannot be sold or transported, under usual circumstances. Pipe line specifications therefore reflect a balance of conflicting factors.

From the standpoint of the industry as a whole, it might be most advantageous to have a specification limit of zero. But attainment of any such theoretical level of perfection is an impossibility, in practice. Some emulsions are easily dehydrated to low levels of water; others are very refractory. For example, Mid-Continent water-content specifications are usually lower than those in California, the former usually ranging from almost nil to about 1 per cent, the latter going as high as 3 per cent. It may properly be said that these levels reflect what the traffic will bear. It is higher in those areas where it has been found impossible to achieve the desired lower levels, in spite of careful processing and considerable expense; it is lower in those areas where reasonably prudent operation has produced more favorable results. The figure for permissible water content that is in general acceptance in any area is therefore the result obtained by balancing a number of technological and economic factors.

The improvement in dehydration results produced by the improvement in reagents and the improvements in their use is eventually reflected in reduced pipe line specification limits. Whereas, for example, early California production technique was able to reduce water contents only to 3 per cent or slightly less, it is less common today to find a producer shipping his oil at very near this level. For one thing, producers prefer a somewhat more comfortable margin. Also, they have learned that reduced water contents mean higher prices for their oil, and other benefits of less tangible nature.

Therefore, it appears that in the not too distant future consideration will be given to further tightening of pipe line specifications, to lower the maximum permissible water-plus-emulsion content. The quality of demulsifying agents is sufficiently high today to make this possible, if reasonably good use is made of their efficiency. The operations of the more careful producers as compared with those of more casual producers will show to what extent this reduction in water and emulsion limits is practicable. A lowering from 3 per cent to 2 per cent does not appear unreasonable, in California.

In some instances, of course, pipe line maxima are already well below this figure, even in that state. Such lower levels have been set after consideration of other factors, like the problem of handling crude containing free water of a corrosive nature, handling appreciable water volumes during the winter months, in colder areas, handling waxy tank bottoms, etc.

If an oil contains residual water to the extent of 1 per cent, if this water has a specific gravity of 1.025, and if this is due entirely to sodium chloride, the oil will contain about 140 parts per million, of salt—far above the usually prescribed salt tolerance.

It is not uncommon to find oils being subjected to chemical demulsifiers for one or more of such purposes, although they may already meet pipe line specifications, as to water and emulsion content.

● **Desalting.** Where the water associated with crude oil is highly saline or extremely corrosive, pipe line limits are likely to be very low, and observance of limits very strict. Newer refinery installations, working at higher pressures and involving larger capital investment than earlier designs, must be protected from the ill effects of salt deposition or destruction of metal vessels by the attack of mineral salts.

Even with the strictest control of water contents of oils, and with very low permissible water contents, the charging crudes are often found to carry too much salt for satisfactory refinery operation. In this case, specifically devised desalting procedures have been developed, which reduce salt contents to a few pounds per thousand barrels. Chemical desalting has become an important prerefining operation, in recent years, and millions of barrels of crude are processed monthly in this manner.

In brief, the desalting operation consists in mixing the charging crude, containing very low water contents in most cases, with a demulsifying agent and with minor proportions of fresh water. The action of the demulsifying agent is such that not only is the fresh blending water recovered, but also the salt-containing water originally present.

● **Resolution of other water-in-oil emulsions.** Demulsifying agents have been so improved that their usefulness has been extended in recent years beyond their original application in connection with the production of crude oil.

For example, refined petroleum oils sometimes become emulsified with water, as water-in-oil emulsions, in steel mills and other industrial establishments. Incorporation of a small proportion of demulsifier in such oils has sometimes produced surprisingly favorable results.

Cracked fuel oils have always produced very refractory water-in-oil emulsions, for example when pumped from ships' tanks along with ballast water. Hundreds of thousands of barrels of such cracked fuel oils have been recovered, containing minimum water contents, in relatively simple installations, in which the reagents have been employed at low cost.

Emulsions produced in blown asphalt plants respond surprisingly well in spite of their high content of emulsion-stabilizing ingredients; and chemical demulsification has been practiced on a commercial scale there for some years.

On completion of oil well drilling, it was formerly the common practice to discard the first production from the well because of its high mud content. Use of chemical demulsifiers permits earlier turning of the well to the tanks.

In acidizing oil wells, stubborn emulsions are sometimes encountered. These are subjected to the action of certain chemical demulsifiers with acceptable results.

Tank bottoms, slop oils, pit oils, caustic wash emulsions, acid treating emulsions, gas oil emulsions, and other refinery and industrial emulsions are also being resolved with chemical demulsifiers in an increasing number of cases.

★ ★ ★

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TULSA, OKLAHOMA

Lester Billington, the author, discusses the operation and maintenance of a field engine with one of his mechanics. One mechanic may have charge of any number of engines from 15 to 80 depending on type, location.

Maintenance procedure in field for internal-combustion engines

By **LESTER BILLINGTON,** Union Oil Company of California

EXCLUSIVE

THE original selection of an engine for field use is normally based on certain highly logical engineering considerations and mechanical requirements, which, if the installation is to give maximum economical service, must by all means take into account the cost and convenience of an adequate maintenance and repair program. An engine may fundamentally develop every ounce of power it was designed to deliver. It may be ideally adapted to the function for which it has been selected. It may even be so constructed as to be easily repaired. But, if the engine itself is not readily accessible for repair work; if minor adjustments and repairs can't be made in the field, and if parts are not immediately available when a repair job develops, the performance advantages may be completely offset by excessive maintenance costs.

By the same token, inability to make repairs in the field and on the job, because of lack of either facilities or qualified mechanics, can add appreciably to the overall cost of operation, by necessitating that the decommissioned engine be disconnected and hauled to a machine shop for handling by expert workmen, while meantime, a substitute or standby engine takes over. It must not be concluded, however, that this is an argument against the use of standby engines. The immediate circumstances involved will always determine whether or not the standby system is logically applicable. Such matters, for example, as well condition and production demand have a distinct bearing on the manner in which repairs shall be performed.

It seems fairly obvious that when an engine repair job can be done right at the operating site, there must at least be a saving of haulage time, and it then becomes a matter of weighing the cost of the engine shut-down time against the saving of repair time. It also seems a fair assumption that with well qualified and well equipped traveling mechanics making periodical inspections, and catching minor irregularities in their incipiency, many of the major repair jobs can be avoided. It is well known, for instance, to safety minded oil men that treatment of apparently inconsequential scratches and cuts in the beginning is the surest way to prevent serious infections later, and it is equally true that the correction of small mechanical deficiencies will often eliminate subsequent trouble of major dimensions. In any case,

this article is not designed to propagandize in behalf of any particular system, but is merely intended to discuss informally a program of engine maintenance, in which one of the important objectives is to organize personnel and facilities for on-the-job treatment, wherever this procedure is deemed practicable and profitable.

Almost, perhaps quite, as important as the choice of the engine itself in such a system, is the selection and education of the traveling mechanics. There are men who have as much genuine regard for engines as other men have for dogs or horses. It hurts them to see an engine being abused, or being allowed to abuse itself, and they simply can't rest until they have done something about it. That is a quality that isn't too easily recognized in a stranger, but may be very apparent in a mechanic who has been employed in another department in your own company, and certainly it will pay to engage such men for this type of work if and when they are to be found.

The desirable qualifications of the traveling mechanic are somewhat different from those of the shop worker, who can solicit the advice of his shop foreman any time he is faced with a difficult problem, and may be confined to some very specialized operation, because of the volume of work being handled. The traveling man should have plenty of initiative. He will be required to make his own decisions in the field, and he must be competent, because errors in judgment may have disastrous results, and at the very least are certain to affect his own standing as an expert in his field, which is not good. He must be familiar with engines in all their aspects, and not just be a specialist in one phase of operation, such as ignition or carburetion. He must have a pleasing personality so that he can make a favorable impression on the district or production foremen with whom he will have to consult and advise. Above all he must be not only a good diagnostician, but also a good surgeon. It is not sufficient to know what is wrong with an engine, unless he proceeds promptly to correct it. The program to which this dissertation refers, incidentally, delegates to the care of one mechanic from 15 to 80 units, depending on the type and location.

Having procured the right kind of men in the requisite number, the next essential is to see that they are properly equipped. Each man is first provided with complete data sheets on all the engines on which he will be required to work. This is supplemented by periodical round table discussions in which points of interest are enlarged upon, current developments are expounded, and specific problems are analyzed. The data sheets give such information as minimum and maximum r.p.m., load conditions as indicated by manifold vacuum, spark setting, timing, valve clearances, and other necessary operational information. The traveling mechanic is given suitable transportation, consisting of an automobile so designed as to be able to carry in compact array all parts and tools required for the performance of minor repair jobs. Other important items in his portable kit are a vacuum gauge, tachometer, fuel pressure gauge, and in some instances a fuel-air gas analyzer.

Engines are placed on a regular service schedule of from thirty to thirty-five days, and, of course, local operators call attention to any extra-curricular service that may be needed in the meantime. A particular indication for which the mechanics must be especially alert is failure of the air filter system. Experience has demonstrated that the unrestricted accumulation of dust and other abrasive materials inside the engine can, under certain circumstances, quickly develop costly breakdowns. As a matter of fact, it seems to be a trade maxim that if this accumulation be allowed to reach a total of from 3 to 5 ounces, the engine will no longer be capable of functioning economically and is ready for consignment to the scrap heap. The oil-bath type filter is conceded to be preferable, but regardless of type, it is imperative that all screens be cleaned at reasonable intervals, and that all connections be kept tight.

Proper timing is highly essential for many reasons. If firing comes too late, the result is excess heat in the combustion chamber, and high piston-head temperature, with consequent loss of power. Coincidentally, this means valve failures, increased oil consumption, and the multitudinous ails that stem from these. On the other hand, an early spark is likely to cause bearing failures, because the power release takes place before the piston has passed top dead center, and the kickback is a direct bearing shock.

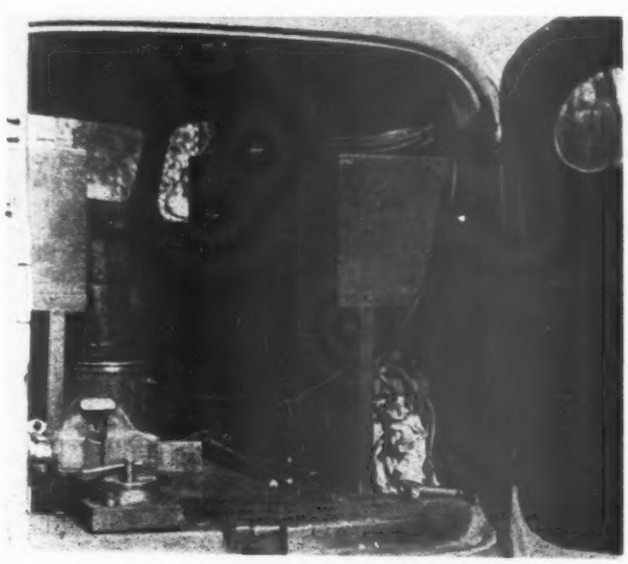
Fuel pressures and carburetion must be watched closely for obvious reasons. Lean mixtures cause exceptionally high cylinder heats, with consequent shortening of valve life, excessive oil consumption, and burnt valves. Rich mixtures also cause abnormal heat, high carbon and soot deposition, with excessive cylinder and piston-ring wear, reduced oil life, and excessive fuel consumption. In general, however, a slightly rich mixture is preferable to one that is on the lean side.

The effect of poor water supply is not to be underestimated. Lime coatings within the jacket act as insulation, and promote high cylinder-wall and valve-seat temperatures. Such conditions inevitably lead to undue oil consumption, valve failures, and general loss of efficiency. It is to be noted in this connection, that the engine condition is not revealed by the water temperature, as the insulating effect works both ways. In other words, the lime scale prevents the water from properly cooling the engine, and at the same time prevents the engine from transferring its heat to the water. The remedy, of course, is to use soft water when it is available or can be made available at a reasonable cost, and to use softeners or inhibitors when necessary to control the effects of hard water where there is no alternative but to use it.

In making his regular rounds, the me-

THE AUTHOR

Lester Billington is a native Californian—born in Los Angeles—and has been active in the petroleum industry for the last twenty years. Beginning with short term engagements for Tide Water Associated and Shell oil companies, he transferred to Union Oil Company's gas department in September, 1925, and has been with that company ever since. In 1929 he was taken over by the service and maintenance department, and when later an automotive division was set up, became a part of that institution. He was appointed general foreman in charge of maintenance and repair in 1940, and played an important part in the definition of the field procedure now in effect.



The traveling workshop that accompanies the mechanic wherever he goes. It is fully equipped to permit the completion of all ordinary repairs and to take care of replacement of small parts right on the job.

NOW-more than ever...

The most advanced pressure control unit available for today's—AND TOMORROW'S—drilling operations

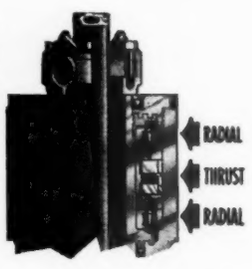
THE SHAFFER TYPE 46 COMBINATION ROTATING BLOW-OUT PREVENTER AND STRIPPER

THE SHAFFER Combination Rotating Blow-Out Preventer and Stripper has long been recognized as the outstanding advancement in the field of pressure control. Not only does it combine in ONE device *every* feature needed for successful and simplified drilling under pressure with the kelly and drill pipe ordinarily used, but it also maintains a continuous pressure-tight seal around *all* elements in the drill string—whether square, round or hexagonal—and all the varying diameters in the drill string, except for such abnormally large diameters as the reamer or bit. What's more, it requires no special operations for handling the pipe and it permits pressure drilling operations to be carried on with the same speed, safety and convenience as normal drilling operations.

New Bearing Design

FURTHER MINIMIZES MAINTENANCE

Now, in the new Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper, a recently-perfected bearing design has been incorporated that further minimizes maintenance. The essential part of the rotating assembly is a rotating sleeve which is carried by a specially-engineered bearing assembly of unique design.



You get complete pressure protection, whether drill string is *in* or *out* of the hole, when you use the Shaffer Rotating Blowout Preventer and Stripper in combination with the Shaffer Double Control Gate.

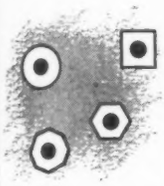
SEPARATE THRUST AND RADIAL BEARINGS: The new bearing assembly splits compound loads into the two components of pure radial and pure thrust, carrying each of these components on separate bearing assemblies. This design has a number of important advantages. For one thing, it prevents thrust shock and vibration from building up on heavily loaded radial bearings . . . and also prevents any radial loads from building up on the thrust bearings. Each type of load is carried on a bearing specifically designed for that type of operation, assuring greater operating efficiency than where combination-type bearings are used.

Another important point—the roller bearings which carry the radial loads are placed a considerable distance apart so as to provide maximum resisting moment to wobble, lateral vibration and other off-center strains. Note in the illustration how this wide radial bearing separation gives maximum resistance to destructive lateral movement in the drill string.

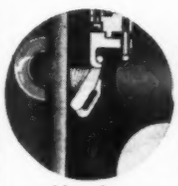
LIFETIME LUBRICATION: Still another advancement—all bearings are pre-packed with a high temperature and high speed stabilized grease that resists oxidation and has excellent lubricating properties even at temperatures as high as 275° F. This lifetime pre-packed lubrication not only eliminates greasing maintenance, but also assures positive lubrication at all times without depending upon crew care and attention.

PLUS all these unique advantages!

No wonder operators everywhere are so enthusiastic about the Shaffer Combination Rotating Blow-Out Preventer and Stripper for complete pressure protection while the drill string is in the hole. Here are a few more of its many advanced features . . .

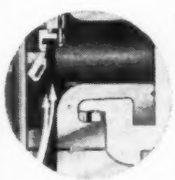


CONTINUOUSLY SEALS AROUND *ANY* SHAPE: Except for such unusually large diameters as reamers or bits, the Shaffer Combination Rotating Blow-Out Preventer and Stripper *automatically* maintains a pressure-tight seal around any of the various shapes and diameters in the drill string. It seals around the kelly—whether square, hexagon or octagon. And it seals around all portions of the drill pipe, couplings and tool joints, thus permitting any type of drill string—flush, coupled or upset—to be used.



ALL SHAPES AND DIAMETERS "STRIP" THROUGH THE UNIT: Not only does the Shaffer Combination Rotating Blow-Out Preventer and Stripper seal around any shape or normal diameter, but it *automatically* maintains this seal as the pipe is stripped in or out of the well. Flexible steel latches built into the stripper rubber form an expandable steel barrier that prevents extrusion when the rubber is subjected to expansion as large diameters are pulled through it. No adjustment or manual operations of any kind are necessary to adjust the stripper rubber to different diameters and shapes, thus assuring *continuous* pack-off against pressure surges, whether the drill string is being rotated, or is being raised and lowered in the well.

NO ROTATIONAL WEAR ON STRIPPER RUBBER: Here's a very important feature—the stripper rubber rotates *with* the kelly at all times, being driven by a floating drive bushing that engages the kelly automatically. Since the stripper rubber rotates *with* the kelly—not around it—there is practically no wear or flexing of the rubber while drilling, thus reducing maintenance and risk of pressure leakage to an absolute minimum.



AUTOMATICALLY SEALS TIGHTER AS PRESSURE INCREASES: Due to the unique design of the stripper rubber, increased well pressures assist in sealing the rubber more tightly against the drill string so that, regardless of sudden pressure surges, there is no leakage. Furthermore, the steel reinforcing latches described above prevent the rubber from extruding or becoming damaged by high pressures, safe-guarding the rubber with a protective steel barrier at all times.

Many other advantages... There are so many unique advancements engineered into the Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper that space does not permit describing all of them. For example, the unit is equipped with a Quick Releasing Bonnet that permits almost-instant release of the internal mechanism for quickly raising and lowering abnormally large diameters such as bits and reamers through the unit. Also, the unit is amazingly compact to reduce overall height requirements to a minimum. What's more, built-in flow connections incorporated in the body below the stripper rubber can serve as a mud cross, eliminating need for this unit in the drilling riser and further conserving space.

No matter what your drilling operations, wherever pressures are to be controlled while drilling, the most advanced, most convenient and most positive method of controlling them is with the Shaffer Combination Rotating Blow-Out Preventer and Stripper. See your nearby Shaffer representative for complete information on this years-ahead control equipment—or write direct for full information. It is available in sizes for handling all drill string diameters from 2⅜" to 8" O.D.

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ENGINE REPAIR AND SERVICE REPORT

Date ____ 194__

Location ____ UP No. ____

Make ____ Model ____ Type ____

Date of Last Report ____ Days Run Since Last Report ____

	Condition	Temperature	Remarks
1. Cooling System			
2. Valves			
3. Motor Block			
4. Bearings			
5. Condition of Oil			
6. Maximum Vacuum with Engine Free			
7. Engine R.P.M.			
8. Power Take-off			
9. Strokes per Minute of Polish Rod			
10. General Condition			

11. Manifold Vacuum—Maximum ____ Minimum ____

Work Done this Trip

Remarks

Signed: ____ Traveling Mechanic

Engine repair and service report form on which traveling mechanics keep uniform accounts of the condition of each engine and the work done at each visit of mechanic.

chanic carries a repair and service form on which he notes the results of his examination, and the nature of the work he has done on each unit. This form, of which a copy is here reproduced, gives all the significant details with respect to the type of engine, location, number of days run since last serviced, and then a brief statement as to the condition of the cooling system, valves, motor block, bearings, condition of oil, maximum vacuum with engine free, engine r.p.m., power take-off, strokes per minute of polished rod, manifold vacuum—maximum and minimum, and general condition. It concludes with a recital of actual work done on the engine during the current trip, and such suggestions as the mechanic may care to make with regard to future service; service effects to date; the manner in which the engine is standing up to the type of work in which it is being employed, and any other matter that seems to be relevant.

The general procedure adopted by the mechanic on his regularly scheduled trips is to service the magneto; check valve clearances; drain and change the oil; check the fan belt and water jacket connections; test spark plugs; adjust the clutch; and take care of the several items already referred to in the description of the service report. If the examination indicates the need of minor repairs, these are attended to forthwith. If, however, a major job is required, and the well can be shut down—this is determined by consultation with the district production foreman—the mechanic is given such assistance as he needs, and takes care of the situation as quickly as possible right on the spot.

In order to further facilitate and expedite the repair program, where there are enough engines to warrant such a step, a box of parts is kept at some convenient location. This usually contains connecting rods, main bearings, piston rings, valve guides, valve springs, valve seats, valves, gasket sets, and many other items, enough, indeed, to permit the performance of a complete engine overhaul and take care of all replacements that are likely to be necessary. When an operator telephones the department to announce that he has an engine of a specific make and model in need of repairs or overhaul, the box already mentioned is sent to him, and when he has completed his job, all parts and accessories he has used from this stock are replaced, and the box is returned to its customary location. This process obviates the loss of time that is ordinarily due to ordering and waiting for parts *after* the need for them has been discovered. Every field mechanic can recall some instance in his own experience in which the time spent in waiting for parts was more than enough to have completed the repair and had the engine running, if the necessary parts and mechanical skill had been immediately available.

The entire process boils down to this: In the oil industry as in all others, time is money, and wherever and whenever a man-hour can be saved without sacrificing the quality of the resulting work, that saving constitutes a progressive step in orderly business conduct. If an engine repair job can be done, and done just as effectively, at the well as it can at the shop, then obviously that is the way to do it. The system described here is predicated on a particular and peculiar set of conditions. It is fully realized that there may be other conditions under which on-the-job repairs are impracticable and uneconomical, but certainly where such a program is justifiable on a cost basis, it produces incidental advantages that make it decidedly attractive.

It may be pointed out in passing, that motility and mobility are two characteristics in which petroleum engineers and petroleum technologists generally, seem at the moment to be intensely interested. There is a definite trend toward the development of mobile drilling and servicing rigs; mobile engines; mobile pumps—everything that can be moved, from derricks to machines of endless variety, is being placed on skids or wheels, so that it can be put to the maximum use. And if, as it appears, there is logic in this trend from stationary to mobile or portable equipment, surely there is equal logic in a swing to mobile service with its greatly expanded operating scope.

Reference was made briefly to the "incidental advantages" of a system of traveling mechanics and on-the-job repairs, and this perhaps should not be glossed over without some explanation. It seems patent that the working life of the traveling mechanic is more than usually conducive to the development of competence and self-sufficiency. He must of his own initiative diagnose, decide, and act. At regular intervals he meets with his fellow mechanics, and under capable direction, engages with them in discussions and expositions of engines—the newest and the oldest—which, with the practical work he is doing, must eventually invest him with a thoroughly helpful and valuable understanding of the machines, their basic principles and functions.

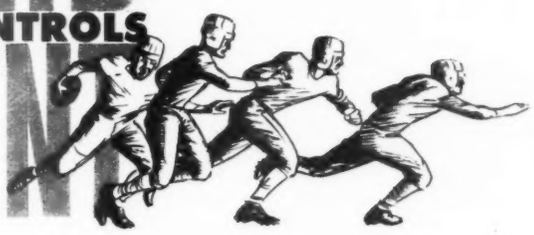
This stepping up of general capability through a combination of experience and education makes the subject more useful to the industry, and gives him that pride of accomplishment and confidence, which is the greatest possible stimulation to his own further advance. In due course, he is so well informed in his specialized business that without being so styled, he automatically becomes a vocational teacher of his craft. At the same time, his practiced powers of observation, and continued concentration, develop data of value to engine designers and manufacturers, and more directly, perhaps, to the research engineers of his own organization. ★ ★ ★

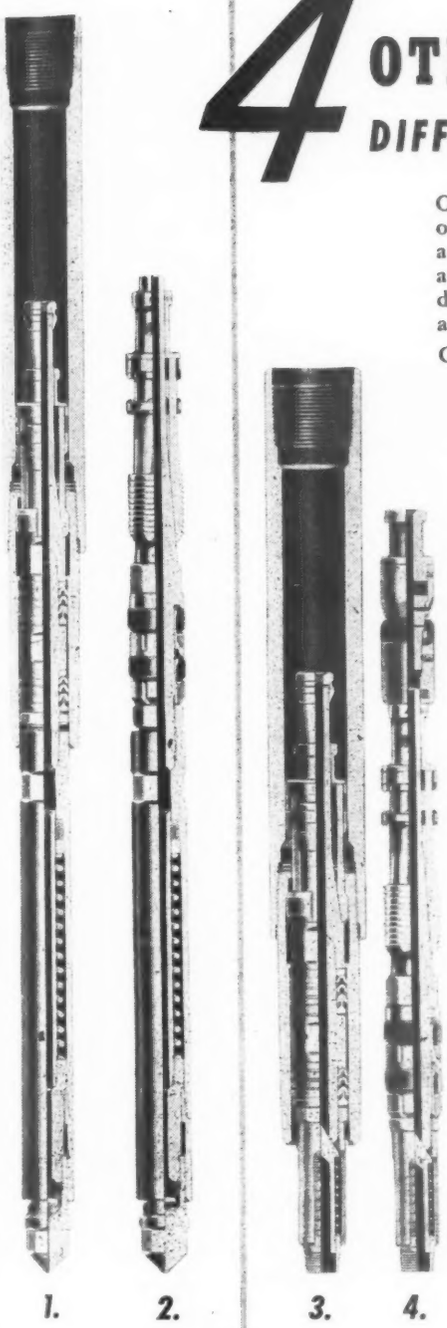
Netherlands plant

Batavian Oil Company's installation near Rotterdam, destroyed by the Germans during the war, is back in operation. The units at Rouen, France, and in Germany are out of service so the Batavian Oil Company is operating the only cracking installation in western Europe.

STANDARD EQUIPMENT

OTIS SUB-SURFACE CONTROLS





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4 OTIS *REMOVABLE* TUBING SAFETY VALVES

DIFFERENT WAYS TO PLAY IT SAFE . . .

Otis Removable Tubing Safety Valves are universally accepted as a dependable means of preventing uncontrolled flow through the tubing. Manufactured from stainless steel and Monel metals, they are always in working order — ready to provide an automatic and instantaneous sub-surface tubing shut-off in case of failure of, or unavoidable damage to, surface connections, caused by storms, floods, etc. All Otis Safety Valves are easy to run and pull on a steel measuring line *without loading the well.*

Check your safety needs! Check these four different ways to play it safe!

1. **The OTIS TYPE FJ REMOVABLE TUBING SAFETY VALVE:** Seats in the Otis Type J Landing Nipple; pressure-differentially operated; recommended for installation in flowing wells before they are completed (or in wells being worked over, etc.); provides positive protection under extreme depth, temperature, and pressure conditions.

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Increased gasoline production at lower cost with improved Houdry reactor design

By **R. C. LASSIAT,**
Houdry Process Corporation
and **C. H. THAYER,**
Sun Oil Company

A MAJOR improvement in the Houdry catalytic cracking process, resulting in both lower operating costs and increased gasoline production, has been effected by re-designing the reactor tubes and changing the physical composition of the catalytic mass.

The new design, developed by engineers of Houdry Process Corporation and Sun Oil Company, is adaptable to all standard Houdry reactors and its advantages have been fully demonstrated by a year's operating experience with a 12-case cracking plant at Sun's Toledo, Ohio, refinery. A similar 12-case, 20,000-bbl. plant at Sun's Marcus Hook, Pennsylvania, refinery has also been equipped with tubes of the new design. In addition, Sun has recently completed the conversion of a third 12-case plant with tubes containing further improvements over those installed in the first two units.

● **Cost of changing catalyst cut sharply.** The cost normally involved in changing catalyst—an item of importance in the operation of Houdry fixed-bed plants—has been reduced markedly by the improved design. Moreover, the new tubes are sturdier and will give longer life, and metal temperatures are lower than heretofore experienced under similar operating conditions.

With the new design, increased production of gasoline results from higher on-stream efficiencies coupled with more even distribution of oil vapor and regeneration air through the catalyst and the presence of a greater supply of heat within the catalytic mass for the cracking reaction. The increased heat supply is provided by a granular, chemically inert material mixed with the catalyst, which has the effect of augmenting the heat capacity of the catalytic mass, as well as other advantages that are described in greater detail in this article.

● **Conversion of reactors is simple.** All distributing orifices and shields, under the new design, are contained on tubes that are easily removable from the top of the reactor for inspection when changing catalyst. Thus, complete cleaning of all distributing elements is possible, at no loss of time, on every catalyst change, resulting in improved distribution of air and hydrocarbon vapors. Existing Houdry reactors can be converted to the new type simply by changing tubes, jacket liner, and top tube sheet. As these items ordinarily have to be renewed after five or six years' operation, no additional expenditure is involved beyond the normal cost of replacement by making the conversion at this time. As the new tube design results in an increased volume of catalyst space, the addition of inert material does not change the active catalyst capacity.

● **Sun's practice in changing catalyst.** In Sun's operations with the previous design of reactors, catalyst life when producing motor gasoline has averaged about 18 months. Beginning with a new plant, the usual practice when making the first catalyst change has been to "shake" out the catalyst. This is accomplished by removing the top head, top catalyst tube sheet and the regeneration tubes, which can be unscrewed from the top. Vibrators are then placed on the cooling and collector tubes, which remain in place, and the catalyst falls out the bottom of the reactor through the holes provided by removal of the regeneration tubes. About 18 months later, when the second catalyst change is made, all tubes are removed from the cases for cleaning and repair. This work consists mostly of removing small particles of catalyst, iron oxide, etc., that accumulate between distributing tubes and orifice protecting shields during operation, straightening out tubes, and repairing

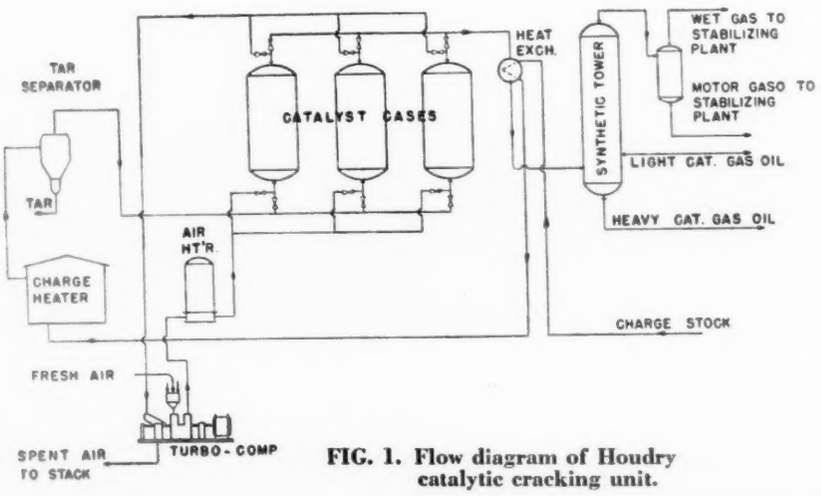


FIG. 1. Flow diagram of Houdry catalytic cracking unit.

FIG. 2. Vertical cross-section of Houdry catalytic case.

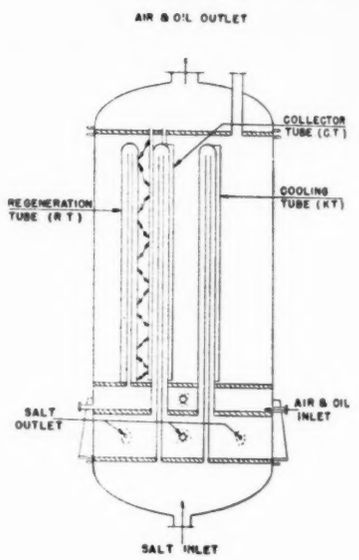
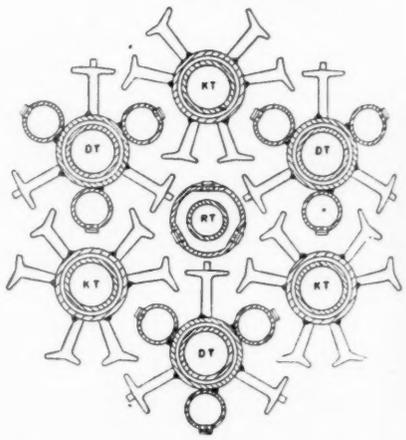


FIG. 2-A. Typical tube pattern Houdry catalytic case.



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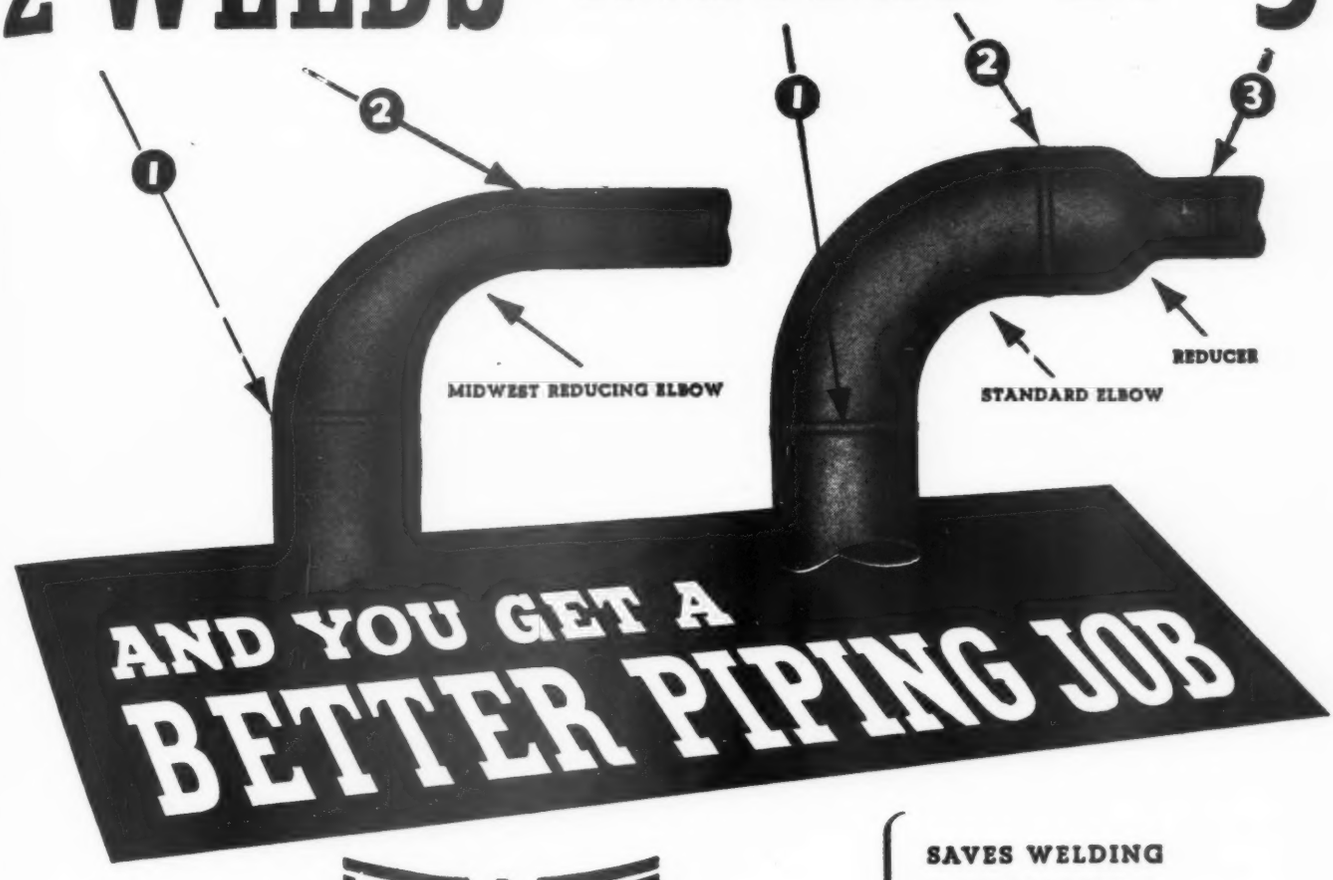

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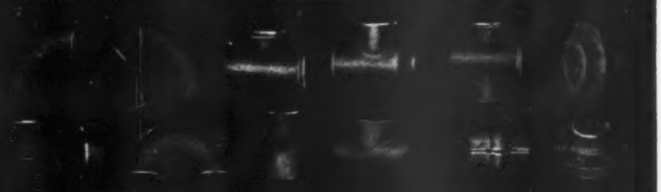

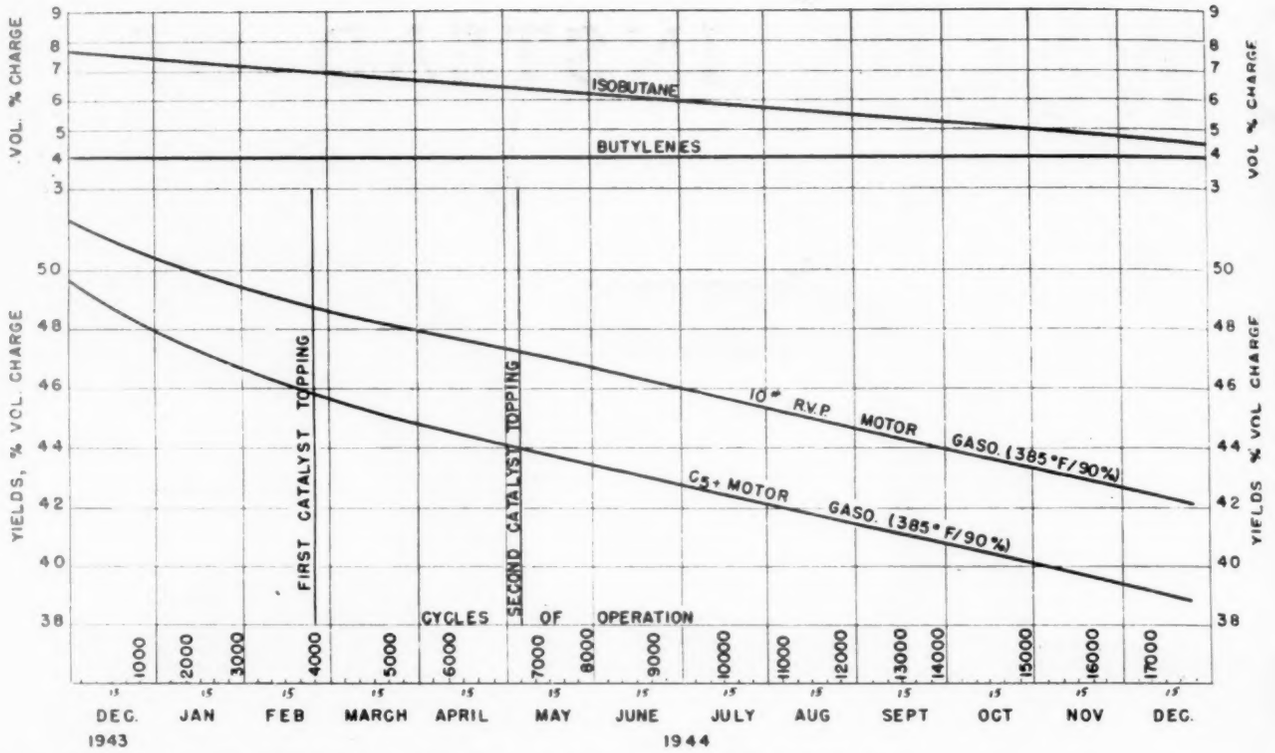

FIG. 3. Catalytic gasoline and butane yield. Plant II-4. December 1943-44 inclusive.

threaded parts that may have been impaired during dismantling.

When making catalyst changes it is general practice to shut-down half of the reactors in a unit and, by changing full throughput through the remaining half, the overall gasoline production during the catalyst change period is about 75 per cent of normal. The shut-down time for one set of six reactors of the previous design for the first catalyst change has averaged 20 days with a minimum labor requirement of 4000 man-hours per case. The second catalyst change, when all tubes are removed, has usually required a shut-down time of six to seven weeks, during which 12,000 man-hours are required per case. A few months ago, by efficient scheduling of all operations, this job was done on a six-case plant of the previous design in 29 days from off stream to on stream.

● **Shut-down time materially reduced.** Catalyst changes, whether it be the first, second, or any subsequent change, with the new type of tube require only seven to ten days from stream to stream and 1200 to 1500 man-hours per case. Inasmuch as all tubes that contain distributing orifices are easily removable from the top of the reactors, distribution of oil vapors and air through the catalytic mass can be maintained almost perfectly without the necessity of removing any of the salt tubes. An improved design has been made for the periphery of the reactors to eliminate any tendency for undue heating of the liner, border tubes, or the shell of the reactors.

As will be seen in the following descriptive section, the interlocking features of the fins have been eliminated to facilitate removal of catalyst and the new fins are extremely sturdy and heavily welded to the cooling tubes. Due to the heavy section of the fins, the additional welding and the reduced surface, the metal temperatures are considerably reduced. The change in design, as shown by results currently obtained in Sun's operations, has resulted in increased production of gasoline through maintenance of the distributing elements in better condition and higher on-stream efficiencies.

● **Design factors of Houdry reactors.** The fixed-bed principle, as utilized in the Houdry Process, is familiar to the oil industry and has been described at length.[1]

Briefly, reactors are usually arranged in groups of three, oil vapors being circulated through one of the reactors, while air is passed through another to burn off the coke deposited on the catalyst by a former "on-stream" period. The third reactor, at the same time, undergoes the processes of oil purge, air purge, and valve changing.

Necessary piping and motor-operated valves insure the continuity of oil and air flow through the system. The valves are operated by an automatic cycle timer and proper electric interlocks preclude mixing of streams.

A molten salt circulated through all reactors removes the excess heat of combustion of the coke and controls the general temperature level.

Fig. 1 shows a simplified flow diagram of a typical Houdry fixed-bed unit.

● **Reactor design.** The design of the fixed-bed reactors is governed by the following factors:

1. Rate of heat removal of the order of 10,000 B.t.u.'s per hr. per cu. ft. of catalyst space.
2. Temperature control during the cracking period.
3. Limitation of maximum temperature, during regeneration period, below values detrimental to catalyst life.
4. Catalyst bed depth and accurate distribution of vapors and air.
5. Mechanical considerations of assembly, thermal expansion, catalyst loading and unloading, etc.

Figs. 2 and 2A show the general arrangement in vertical and horizontal sections of a type of reactor widely used.

Several years of commercial operation have shown that insofar as temperature control, yields and catalyst life are concerned, the design has been satisfactory. Results predicted in laboratory evaluations have been maintained over long periods of time as illustrated by Fig. 3, which shows a typical plant performance diagram over a period of 12 months.

In this plant a heavy distillate obtained mostly from East Texas crude was processed for the production of debutanized gasoline and B-B cut. The reactor charge is a high boiling tar separator overhead of the following characteristics:

Init.	430°F.	30%	675	90%	875
5%	525	50	730	95	915
10%	575	70	785	EP	1000+

● **Mechanism of heat transfer in fixed-bed reactors.** Fig. 4A shows a typical temperature pattern obtained during a complete cycle in a laboratory pilot unit similar in tubular arrangement to conventional commercial reactors, and where accurate temperature measurements are taken. The chart shows that the rate of combustion is rapid as indicated by the fast increase of temperature during regeneration and that the progression of

[1] "The Design and Operating Features of Houdry Fixed Bed Catalytic Cracking Units." R. H. Newton and H. G. Shimp, *The Petroleum Engineer*, October, 1945.

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FIG. 4-A. Typical temperature pattern. Conventional design.

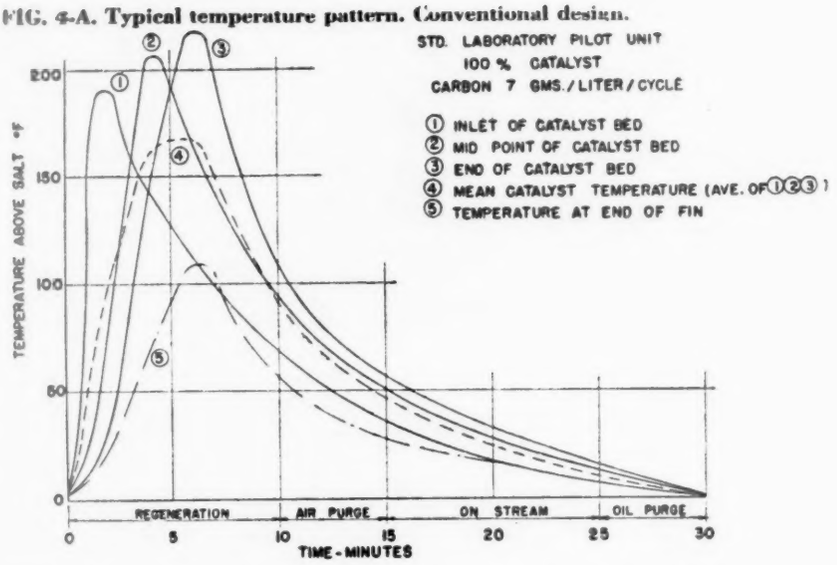
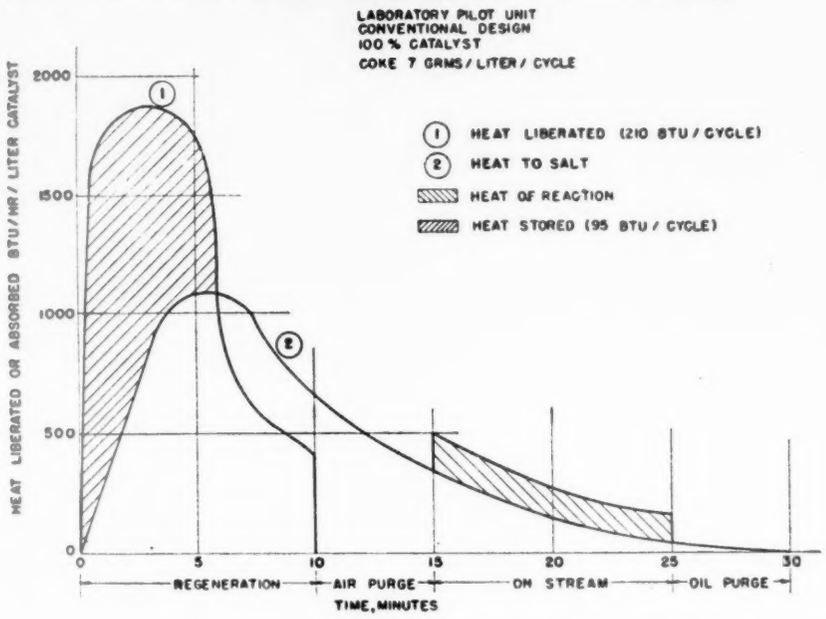


FIG. 4-B. Heat liberated and absorbed during cycle. Conventional design.



combustion through the bed occurs in a fairly narrow zone as the maximum temperatures are attained at the end of the bed after combustion is complete at the front. It also shows temperatures attained at the top of the fins having the design shown in Fig. 2A.

On Fig. 4B are plotted the rate of heat liberation as measured by the analysis of the regeneration flue gas and the rate of heat absorption as measured by the temperature diffential between catalyst and cooling medium. At their point of intersection the area between the two curves represents the total heat absorbed by the catalyst and the finned elements. This heat is released subsequently during the air purge and the on-stream period by the salt and also the heat of reaction.

● **New simplified design.** The analysis of heat transfer in the conventional reactor and the study of the difficulties encountered in maintenance and changing of catalyst have resulted in the development of a new simplified design of the following characteristics:

1. Cooling surface substantially decreased and interlocking of fins eliminated to insure free flow of catalyst. (See Fig. 5). As seen by the temperatures indicated in the diagram, the peak and average temperatures of the fins are lower than formerly, thus the rate of oxidation is materially reduced.

2. Heat capacity of catalyst increased by mixing the pellets with a granular, chemically inert, cheap material of high volumetric heat capacity, which is easily recoverable during catalyst changes. The effect of this chemically inert material is to limit the temperature rise of catalyst during regeneration and the temperature fall during on-stream periods.

3. All tubular elements conveying air and oil vapors to and from the catalyst space easily removable, being assembled by a threaded joint in the lower tube sheet. In the former design the air out-

FIG. 5. Longitudinal section. Modified design.

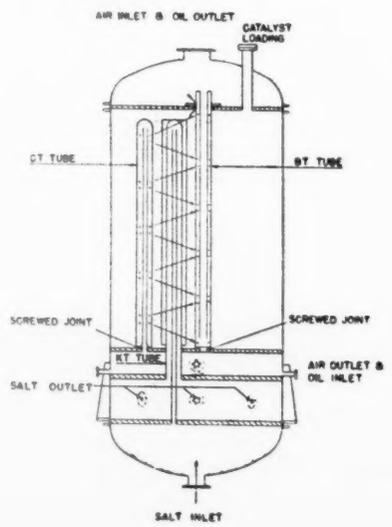


FIG. 5-A. Typical tube pattern. Modified design.

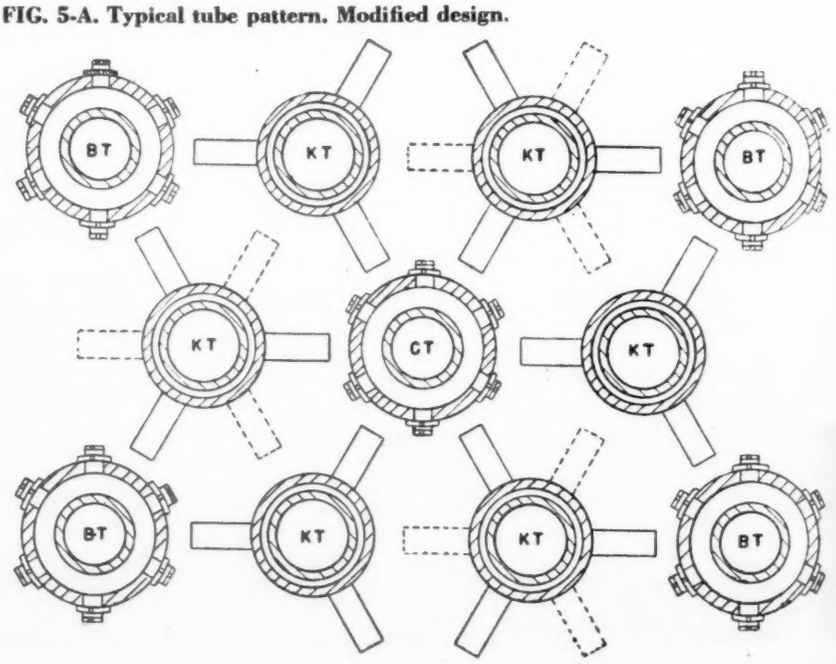


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FIG. 6-A. Typical temperature pattern. Modified design.

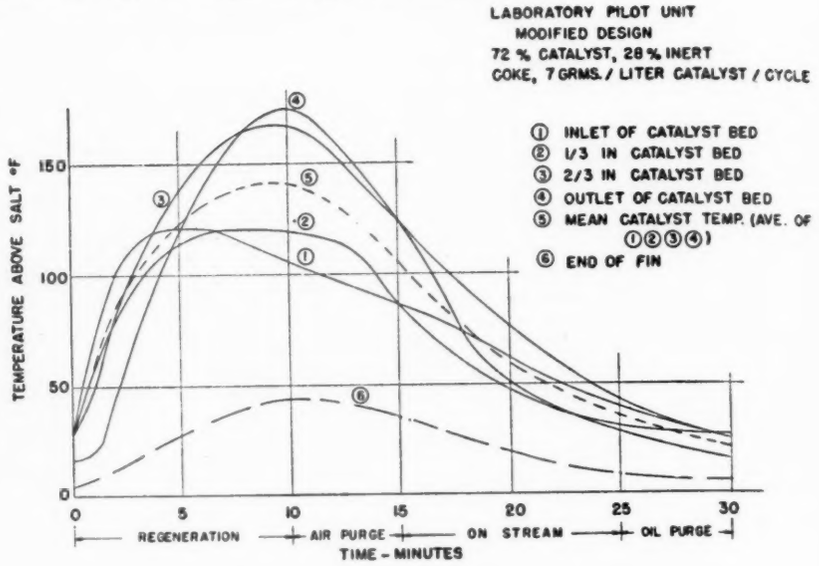
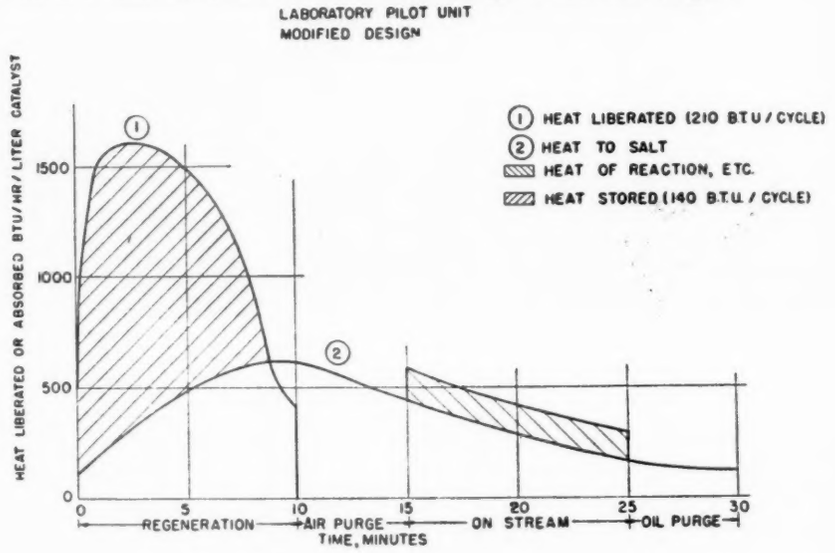


FIG. 6-B. Heat liberated and absorbed during cycle. Modified design.



let tubes were welded to their respective salt tubes (D.T.) and hence their inspection and cleaning necessitated dismantling the reactors, including the rolled and welded joint of the salt tubes.

Fig. 5 shows the general arrangement of the new design as used in one of the Sun Oil Company units that has been in operation for the last year.

Figs. 6A and 6B show the plot of temperatures during the cycle and the respective rate of heat release and heat absorption.

By comparison with the similar plots of Figs. 4A and 4B, the following conclusions may be drawn:

1. The overall rate of heat transfer being decreased, the differential temperature between catalyst and salt is higher during the on-stream period. This factor is corrected by adjustment of the other operating variables such as salt temperature and on-stream pressures.

2. At the same carbon burn-off, the temperature differential during the regeneration period is lower, due to the increased heat capacity of the system.

3. The effect of the variation of heat transfer and heat capacity is shown by the large increase in heat absorbed in the catalyst during the regeneration period.

The experience of the first year of operation has led to certain additional improvements that are now incorporated in the latest units built, as follows:

1. Addition of fins on one half of the K.T. tubes (shown in dotted lines on Fig. 5A) resulting in an increase of coke-burning capacity, all the advantages of the design remaining.

2. Replacement of the packing insuring tightness of the top tube sheet against the tubular elements carrying oil and air to and from the top of the cases to the catalyst space by a stainless steel bushing providing enough clearance for passage of part of the air and vapors. Adjustment of orifice sizes governing the flow through the upper bed is made to insure proper distribution. With this scheme, the time of removing packing, as well as cost of replacement, are eliminated. ★★★

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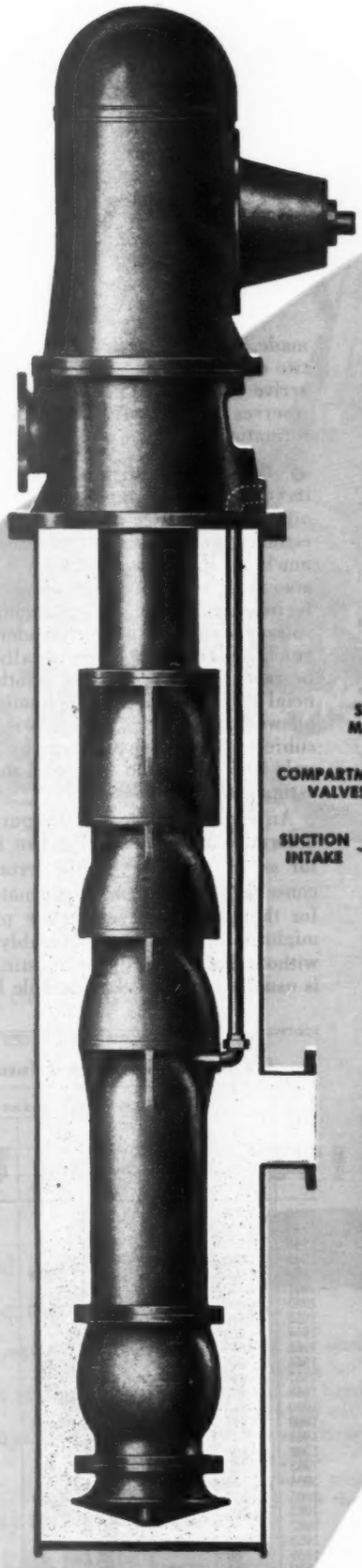

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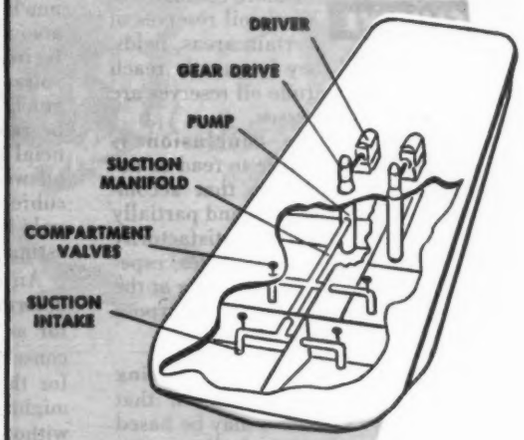

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Notes on estimating crude oil reserves

By **K. MARSHALL FAGIN**
Field Editor

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MANY oil men, including executives, superintendents, engineers, geologists, and accountants, are puzzled by great differences that often exist between two or more estimates of crude oil reserves of certain areas, fields, or properties, and they frequently reach the conclusion that crude oil reserves are simply "glorified" guesses.

This unreasonable conclusion is caused partially by failure to read or understand the explanations that accompany many of the estimates, and partially by failure of the authors to satisfactorily qualify or explain their estimates, especially the methods used in arriving at the estimates and occasionally the purpose for which the estimates are made.

● **Methods and purposes of making estimates.** It is generally known that crude oil reserve estimates may be based on: (1) The production decline curve method, (2) the volumetric method, or (3) the analytical method, i.e. a detailed analysis of the production history and projection of this history into the future. In some oil fields, such as piercement type salt domes, none of these methods may provide a reasonable basis for a reserve estimate, and the estimates used are necessarily only arbitrary opinions.

Some of the purposes for which crude oil reserve estimates are made include: 1. Evaluation of properties for (a) sale, (b) purchase, (c) loans, (d) ad valorem taxes, (e) depletion, and (f) inventory; 2. determination of feasibility of investment in (a) wells, (b) lease and field treating equipment, (c) pressure maintenance, (d) secondary recovery systems, (e) gasoline plants, (f) pipe line extensions, (g) increasing pipe line capacity, and (h) other field facilities; 3. evaluation of the results being obtained by (a) exploratory drilling, (b) redrilling old fields, (c) pressure maintenance, (d) secondary recovery, and (e) other changes in drilling, completion, or producing practices; and 4. determination of (a) economic producing rates, (b) supply of recoverable oil by grades, location, depth, etc., (c) equity of proration allowable formulas for withdrawal, and (d) other legal and statistical matters.

With all the above purposes for which an estimate of crude oil reserve may be made, it would be truly remarkable, if two equally competent individuals could arrive at the same estimate of crude oil reserves from identical sets of basic information.

● **Recovery factors and economic limits vary.** The problem of estimating crude oil reserves is not usually as simple as estimating natural gas reserves, inasmuch as the recovery factor (ratio of amount recovered to the amount originally in place) from oil producing reservoirs varies over a much wider range, much of the oil in place usually has to be recovered by pumping or other artificial methods, and the economic life of oil wells, properties, or fields is usually subject to much speculation by individuals who weigh the facts and make the estimates.

An estimate made for the purpose of determining the price that can be paid for an oil property should certainly be conservative, whereas an estimate made for the purpose of selling the property might reasonably be considerably higher without being unduly optimistic. There is usually room for considerable latitude in the interpretation of a given set of facts.

The more one studies some of the past estimates of crude oil reserves, the more he becomes convinced that, by and large, most estimates for fields are unrealistically low. Part of this is due to the desire to keep an estimate safely within the bounds of insufficient information about a field, part is due to inadequate analysis of the facts, and part is due to improvements in operating practices and techniques that could not have been forecast when the estimates were made. These are some of the reasons for upward revisions of estimates.

It should not be inferred that nearly all estimates are too low. Many fields, especially new fields, are given credit for

TABLE 1.—Approximate annual production—Thousands of bbl.

Year	McCamey	Bosco	Loma Novi
1925	10	....	....
1926	1,900	....	....
1927	7,500	....	....
1928	4,680	....	....
1929	3,480	....	....
1930	2,880	....	....
1931	1,880	....	....
1932	1,520	....	....
1933	1,470	....	....
1934	1,550	1,060	....
1935	2,030	6,370	780
1936	5,000	4,580	4,850
1937	6,400	3,020	6,440
1938	5,600	2,080	4,650
1939	4,900	1,690	3,440
1940	4,200	1,700	2,800
1941	3,550	1,500	2,190
1942	3,200	1,380	1,670
1943	3,200	1,090	1,610
1944	3,300	1,050	1,390
1945	3,200	1,000	1,090
Approximate Cumulative	71,450	26,520	30,910

TABLE 2.—Estimated future production by years—Thousands of bbl.

	(From a semi-log paper decline curve)						(From log-log paper decline curve—Fig. 1)					
	McCamey		Bosco		Loma Novia		McCamey		Bosco		Loma Novia	
Year	During year	Cum. future	During year	Cum. future	During year	Cum. future	During year	Cum. future	During year	Cum. future	During year	Cum. future
1946	2,700		900		800		2,850		940		950	
1947	2,300		800		600		2,550		880		840	
1948	1,950		720		440		2,300		840		740	
1949	1,650		650		330		2,100		790		660	
1950	1,400	10,000	595	3,655	245	2,415	1,900	11,700	750	4,200	590	3,780
1951	1,180		535		180		1,750		720		530	
1952	1,000		480		135		1,600		680		490	
1953	840		430		100		1,500		660		440	
1954	720		390		74		1,400		630		400	
1955	600	14,340	350	5,850	55	2,959	1,300	19,250	600	7,490	380	6,020
1956	520		320		40		1,200		580		350	
1957	440		290		30		1,140		560		320	
1958	370		260		23		1,050		540		300	
1959	310		230		17		1,000		520		280	
1960	265	16,245	210	7,160	12	3,081	960	24,600	510	10,200	260	7,530
1961	225		190				920		490		245	
1962	190		170				890		480		230	
1963	160		155				860		465		215	
1964	140		140				830		450		205	
1965	115	17,075	125	7,940			800	28,900	440	12,525	195	8,620
1966	100		112				780		430		185	
1967	84		100				760		420		175	
1968	70		90				730		410		165	
1969	60		82				700		400		160	
1970	50	17,439	74	8,398			680	32,550	390	14,575	150	9,155
1971	42		66				660		380		145	
1972	36		60				640		370		135	
1973	31		54				630		365		130	
1974	26		48				620		360		125	
1975	22	17,596	44	8,670			600	35,700	350	16,400	120	10,110
1976			39				580		345		115	
1977			35				570		340		110	
1978			32				550		330		107	
1979			29				540		325		103	
1980			26	8,831			530	38,470	320	18,060	100	10,645
Total	17,596		8,831		3,081		38,470		18,060		10,645	

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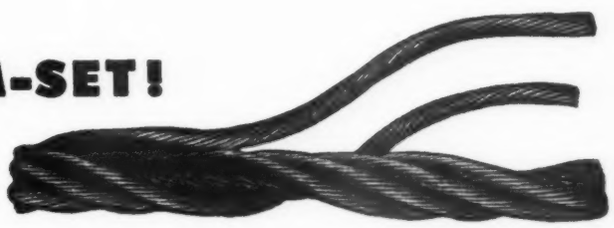

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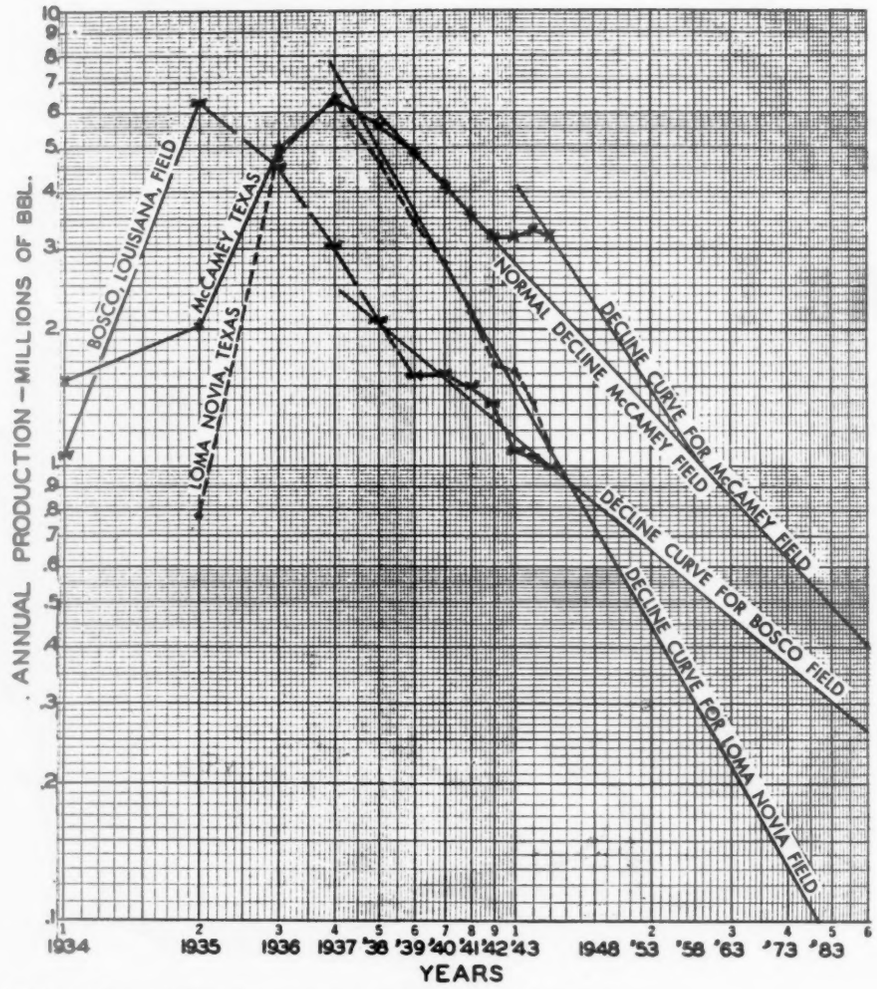
ANNUAL PRODUCTION—MILLIONS OF BBL.
BOSCO, LOUISIANA, FIELD
McCAMEY, TEXAS
LOMA NOVIA, TEXAS
NORMAL DECLINE McCAMEY FIELD
DECLINE CURVE FOR McCAMEY FIELD
DECLINE CURVE FOR BOSCO FIELD
DECLINE CURVE FOR LOMA NOVIA FIELD
1934 1935 1936 1937 '38 '39 '40 '41 '42 '43 1948 '53 '58 '63 '73 '83
YEARS

FIG. 1. Production decline curves on log-log graph paper.

having crude oil reserves that later turn out to be much too high, and it is important for those who wish to keep up-to-date on crude oil reserves to review periodically all their estimates and revise them, if necessary.

● **Volumetric and decline curve methods.** Estimates of crude oil reserves for new fields and fields with controlled or restricted production rates cannot be made by the production decline curve method until the production has declined naturally for two or three years.

The volumetric method of calculating the oil in place and estimating the per cent recoverable is most adaptable to new fields. This consists simply of estimating the productive area, the net effective thickness of the oil producing formation, the recoverable oil contained originally in the reservoir, and subtracting the cumulative production. The remainder is the estimated crude oil reserve of the field.

For example, a new field is estimated to have 1000 acres of producing area, and an average of 50 ft. of effective pay sand. Analysis of cores from some of the wells indicates that the pay sand has an average porosity of 25 per cent and contains 30 per cent connate water; and, analysis of the oil indicates a shrinkage factor of 15 per cent:

Then, $1000 \times 50 = 50.000$ acre-ft. of pay sand

And, $7758 \times 0.25 \times (1.00 - 0.30) =$ 1360 bbl. of oil in place per acre-ft.

Then, applying the shrinkage factor and an estimated recovery factor of 30 per cent:

$1360 \times (1.00 - 0.15) \times 0.30 =$ 350 bbl. of recoverable oil per acre-ft.

Then, the field is estimated to have contained originally $50,000 \times 350 = 17,500,000$ bbl. of recoverable oil. Subtraction of 250,000 bbl. cumulative production as of January 1, 1946, leaves an estimated 17,250,000 bbl. crude oil reserve as of January 1, 1946.

It should be explained that the 17,500,000 bbl. estimate of recoverable oil originally in place is often referred to as the "estimated ultimate production," while the 17,250,000 bbl. estimated crude oil reserve is the same thing as "estimated future production."

In cases where the porosity, connate water, and shrinkage factors are not available, recovery estimates of so many bbl. per acre-ft. are often made on the basis of a general comparison of the pay formation in the new field with known or estimated recoveries per acre-ft. from similar formations in nearby or comparable fields. Even in cases where the core analysis and other data are available, it is usually wise to adjust arbitrarily the result of any calculation downward or upward to some extent, in the light of any reasonably good comparison that it is possible to make with known recoveries from similar pay formations in older fields.

● **Example of the decline curve method.** Fig. 1, illustrates the plotting of annual production figures on log-log graph paper to obtain a straight line extrapolation of future annual production. Table 1 shows the approximate annual production of the three fields. These figures were plotted on the log-log paper; the general slope of the decline in each case, except for McCamey, was apparent; and a line was drawn through the last known point (for the year 1945). The estimates of future production from these fields, by years, (Table 2) are simply the readings taken along these lines.

Some individuals prefer to plot the annual production against time on semi-log paper, and the readings from an extension of the decline curves for these three fields as plotted on such graph paper are shown in Table 2 for the sake of comparison with readings from the log-log curve (Fig. 1), and to show how some of the differences in estimates of reserves of older fields may occur.

The main problem in estimating the reserves of older fields such as these is to decide where the production will practically cease, due to the decreasing production, increasing lifting cost per bbl. of oil, and need for extensive well repairs. It is a problem of economics.

Encroaching water or an expanding gas cap may reduce the number of producing oil wells, and the rate of production from the field may be less than the curve indicates, or a clean out and repair program due to higher crude oil prices may cause the production to increase above the curve. Changes in production practice or equipment may also maintain or increase production.

Use of this method simply enables individuals to control their estimates of crude oil reserves in accordance with established trends in given fields, but does not indicate additional amounts of oil that may be expected should secondary recovery methods be introduced, or extensions or new formations be drilled.

Probably every individual who reads Table 2 will have a different idea of the time that these fields will last and the amount of oil that they will produce, but it should be borne in mind that very few, if any, fields as important as these have ever been completely abandoned.

● **The analytical method.** The analytical method of estimating crude oil reserves is most widely used for estimating the reserves of fully developed fields that are being produced at controlled or restricted rates. It involves the use of the volumetric method of estimating reserves, the use of reservoir pressure decline vs. cumulative production curves, calculation of effective oil-producing formation that remains after some has been voided due to water encroachment or gas cap expansion, material balance, and other methods of estimating reserves by projecting a detailed analysis of the production history of a field into the future.

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Warm-worked casing—a new oil country product*

By **J. JAY DUNN**†
National Tube Company

THROUGHOUT the development of the petroleum industry the casing of deep wells has presented a serious and complicated problem to the maker of pipe used for this purpose. The depth of wells has increased from a few hundred feet to more than 16,000 ft. and, at the present time, depths of 18,000 ft. are being seriously considered. The average depth of wells drilled in the United States has remained fairly constant over the last 20 years, but the footage drilled beyond 5000 ft. in depth has progressively increased. Thus, the importance of the resistance of pipe used in deep wells to external fluid pressure has been correspondingly emphasized.

Pipe used to case deep wells may be subjected to an unbalanced external fluid pressure, due to a hydrostatic head, equal to the well depth. The specific gravity of the fluid is assumed as not less than 1.153. In some circumstances it may be as high as 1.47. The design of strings of casing, in general, requires at least two pipe sizes; the outside diameter of the coupling on the smaller pipe must clear the inside diameter of the pipe through which it must pass. This imposes a strict limit on the wall thickness. Strength of the hoisting tackle and power of the engine, as well as cost, are further restrictions on dimensions. The economic answer is to be sought mainly in the strength characteristics of the pipe material. Warm-worked casing provides an answer to the problems involved.

In the warm-working process, the final reduction to size ranging up to some 8 per cent of the diameter is made at a temperature between the blue brittle range and the lower critical temperature. The result is casing with high transverse compression and longitudinal tension properties. The increased transverse compression strength leads to high collapse resistance and the increased longitudinal tension strength to increased joint strength. A wide range of the improved properties is possible by variation of the per cent reduction and temperature. Contrary to expectation the physical properties produced by warm working are greatly increased over those obtained by cold reduction and subsequent aging treatment.

*Reprinted from *Iron and Steel Engineer*, publication of Association of Iron and Steel Engineers, July, 1946.

†Assistant to vice president, National Tube Company, U. S. Steel Corporation subsidiary.

There is much of interest to engineers and, to express it mildly, not a little to be learned from a study of the efforts made over the last forty-odd years to solve this problem of deep-well casing. It is proposed to review briefly a few of the published investigations of the problem and to present in outline the work carried out by the research organization of National Tube Company in seeking to improve the collapse resistance of deep-well casing.

The earliest investigation of the resistance of pipe to external pressure as that problem related to the oil industry was undertaken by Reid T. Stewart[1].

Stewart states that the purpose of his investigation was the "supplying an urgent demand for reliable information on the behavior of modern wrought tubes when subjected to fluid collapsing pressure." The fact that a large proportion of the pipe tested was designed as casing leads one to credit the urgent demand as coming from the oil industry.

The plan and the execution of the test program cannot be improved upon today for the purpose of supplying reliable information on the collapse resistance of casing for the use of the oil industry. The test data related to a definite commercial product class. The test specimens were selected with a close approach to random choice. The report presented sufficient data to permit examination of the conclusions reached.

In evaluating his test results, Stewart limits his conclusions to lengths greater than "about six diameters," and combines all the variables such as characteristics of the steel, out-of-roundness, variation in wall, and others, suspected and unsuspected, in constants for the pipe class. Then the collapsing pressure is expressed as a function of the pipe dimensions.

In this manner Stewart derives two equations:

For pipe having a $\frac{t}{D}$ ratio of 0.023 or greater

$$P = 86670 \frac{t}{D} - 1386 \quad . \quad . \quad . \quad (B)$$

For pipe having a $\frac{t}{D}$ ratio less than 0.023

$$P = 50{,}210{,}000 \left(\frac{t}{D}\right)^3 \quad . \quad . \quad . \quad (G)$$

The distribution of the test results is stated in per cent departure from the formula values. Thus, "not one of the several hundred tubes tested failed at a pressure lower than 42 per cent of the probable collapsing pressure, while ½ of one per cent of the number of tubes failed at 37 per cent and 2 per cent at 25 per cent of that pressure." Checking these percentages with the data, it is found that the calculated pressures were for the measured pipe dimensions, and the intention was to say that not one of the several hundred tubes tested failed at a pressure lower than 42 per cent *less* than the probable collapsing pressure.

This method of evaluating the test results is not too questionable if the purpose were to determine the relation of pipe dimensions of a class to the collapse resistance. The statistical average of the test collapsing pressures was 99.1 per cent of the calculated values with a coefficient of variation of 11.11 per cent. For the pipe user, however, the method fails to provide needed information. His pipe orders specify a nominal size of a class. It is the nominal and not the actual dimensions that should be used with formula developed from the measurements of test specimen. When the formula pressure is calculated on the basis of the nominal dimensions, Stewart's test data (217 tests, Figs. 34 to 41, inclusive, Stewart's paper) present a statistical average of 98.4 per cent of the calculated values with a coefficient of variation of 18.8 per cent. The effect of this great increase in this coefficient is shown in Table 1.

TABLE 1—Per cent of the ratio, test pressure to calculated pressure, using nominal pipe dimensions.

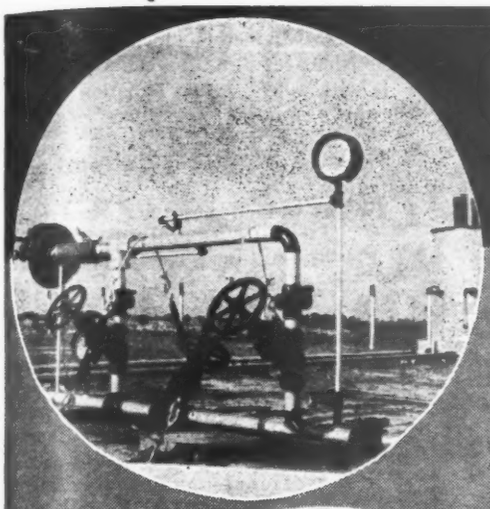
Stewart's data, Figs. 34 to 41, inclusive

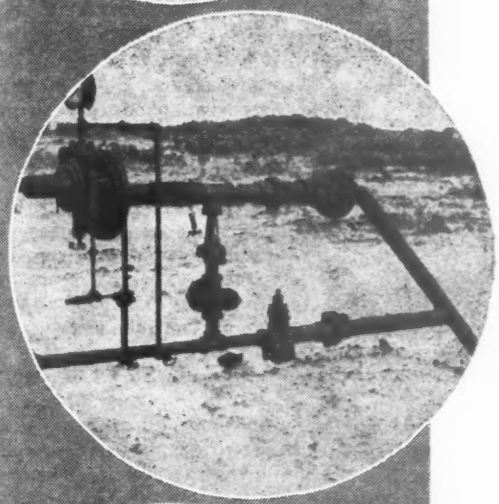
Ratio less than	Per cent of total
0.75	9.67
0.70	6.45
0.65	3.22
0.60	1.38
0.50	0.46

The lowest ratio was 0.4883 for test No. 243. Stewart's value for this test was 0.83. This is an extreme. Stewart's recommended factor of safety, under the conditions of use as well casing, would give, as a rough estimate, a probable failure of one in three million lengths of pipe. However this may be, his data were used with satisfactory results for many years. It was only when seamless pipe assumed an important position in the casing of deep wells that Stewart's test data required revision.

Shortly after the first world war, seamless pipe became available for well casing. Previously the process had demonstrated its quality for rotary drill pipe. Initially, the product was confined to steel grades A and B, having minimum yield strengths of 30,000 and 35,000 lb.

[1]"Collapsing Pressures of Bessemer Steel Lap-Welded Tubes," Prof. Reid T. Stewart. *ASME Transactions*, Vol. 27, 1906.





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per sq. in. When grade C with 45,000 minimum yield strength was produced, the question of collapse resistance required an answer.

Prof. Stewart, using test data he developed with National Tube Company, revised his formulae on the assumption that collapse resistance was determined by yield strength. Hence, expression (B) was made to apply to seamless pipe by multiplying the expression by the ratio of the average yield strength of the seamless to the average yield strength of the bessemer lap-welded pipe used in his early tests.

The formulae as revised fitted the data about as well as for the lap-welded pipe for the soft grades. For the grade C, the fit was noticeably of wider spread.

The grade C casing 7 in. by 30 lb., which is the advisable heaviest weight for the diameter, had a calculated safe setting depth of 5315 ft. Pipe of this $\frac{D}{t}$ ratio was required at the time for only about 5 per cent of the total. But well depths were increasing, and the economy of stronger pipe was obvious. To meet the demand, National Tube Company, from its long experience with cold drawn tubing, considered the possibility of producing a high strength pipe for casing by cold sizing the usual hot-rolled product. Tests resulted in an unexpected great increase in the collapse pressure, but the pipe shattered to such an extent under the failing pressure that the idea was abandoned. It was not realized that shattering under a collapsing pressure is not a measure of ductility unless consideration is given to the energy stored in the test jacket and to the pipe dimensions. The idea was abandoned the more readily as a desirable increase in collapse resistance was obtained by a simple carbon-manganese chemistry in the hot-rolled product leading to the API Grade D.

Great interest was created in this question of collapse resistance of pipe by a paper presented by Jasper and Sullivan[2] in 1931. Their paper, after considering several variations of the rational expression for the collapse of tubes at stresses in the elastic range, proposed calculating the collapse resistance as a function of the ratio of the pipe diameter to the pipe wall and the stress read from a set of curves relating the pipe dimension to the failing stress at various yield strength levels. These curves are reproduced here as Fig. 1. The envelope curve indicated as 1 is calculated from Sturm's equation. A simple and approximately correct form for this equation is:

$$P = \frac{C}{(D/t)^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C = \frac{2\,E}{(1-\mu^2)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The authors use, to express the relation of collapse pressure to the unit stress:

$$P = \frac{2\,(D/t-1)\,\sigma}{(D/t)^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

For most collapse problems no material error is introduced by replacing (3) with:

$$P = \frac{2\,\sigma}{(D/t)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This substitution results in a simple expression when P is eliminated between (1) and (4), giving:

$$\sigma = \frac{C}{2(D/t)^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

In these expressions:

D = outside diameter of the pipe,
t = wall thickness of the pipe,
E = Young's modulus,
μ = Poisson's ratio,
σ = unit stress at pressure P, and
P = critical collapsing pressure.

These equations apply to pipe not less than eight diameters in length and for dimensions resulting in elastic stress.

It will be noted that equation (1) is Stewart's equation (G) with

C = 50,210,000

The data presented in the paper consisted of:

256 lap-welded bessemer steel pipe (Stewart's results),
21 perfect (machined) tubes, Prof. Carman,
14 arc-welded pipe, and
4 seamless pipe.

The four tests on seamless pipe and Stewart's data are the only tests in which the collapsing pressure stressed the pipe beyond the elastic stress range. Consequently, the data do not permit any check of the curves other than boundary Curve 1. The use of the diameter to wall ratio instead of the reciprocal as used by Stewart has come into general use.

The Jasper and Sullivan paper devotes extensive space to considering the effect of out-of-roundness and variation in wall thickness on the resistance to a collapsing pressure. Data from 199 of Stewart's tests used to compare the stress calculated from the collapsing pressure and pipe dimensions with the stress for perfect tubes. The difference between these two figures expressed as a percentage of the perfect tube is assigned as the effect of out-of-roundness. The authors stated they were forced to assume that the effect of wall variation was relatively unimportant, alleging the data were not sufficiently complete to permit separation of the two effects. A more precise statement is that the data indicated a wide range in the combinations of wall variation and out-of-roundness.

The stresses for the perfect tube were determined by reading the stress from a curve for the average yield strength of Stewart's pipe material—viz., 37,000 lb. per sq. in., similar to the yield strength curves of Fig. 1.

Their analysis resulted in depicting

[2] "The Collapsing Strength of Steel Tubes," T. McLean Jasper and John W. W. Sullivan. APM-53-17b, *ASME Transactions*, 1931, pp. 219-245.

FIG. 1

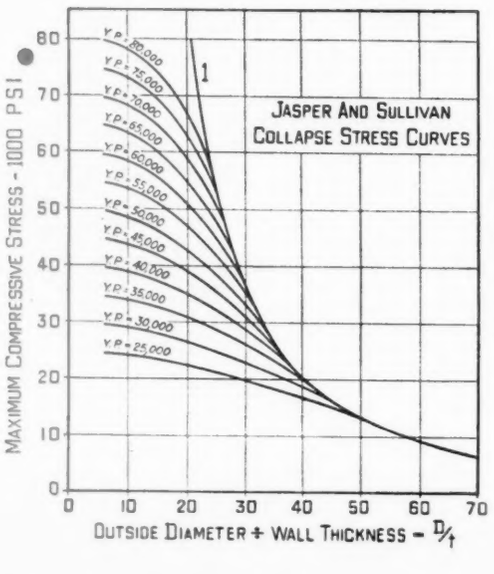
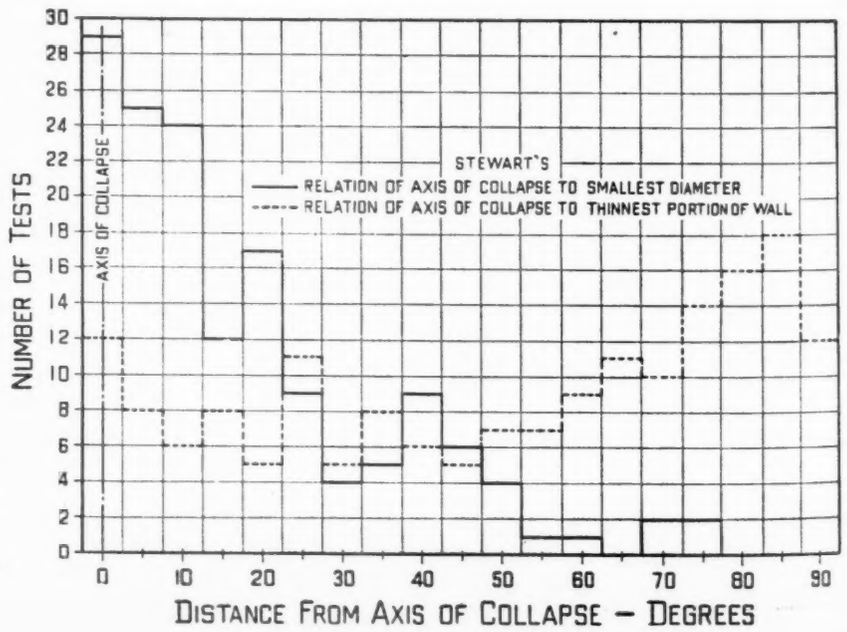


FIG. 2



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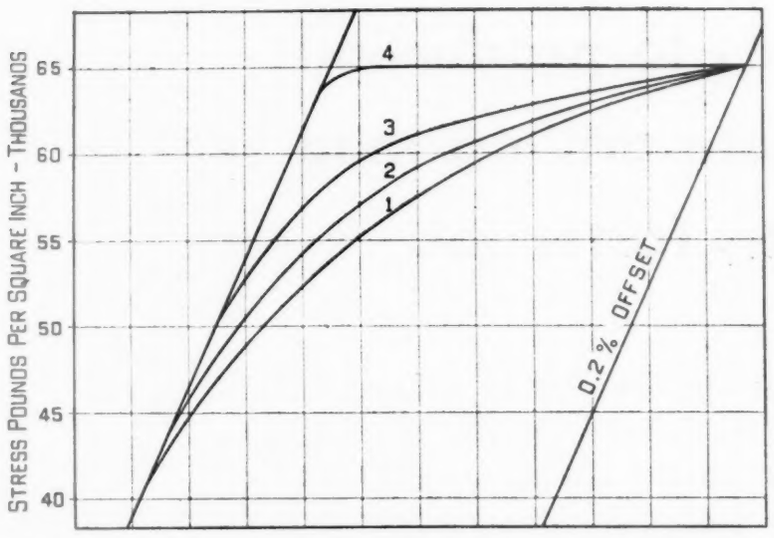


FIG. 3 STRESS - STRAIN CURVES

the effect of the combination of ovality and variation in wall thickness as a straight line relation between the D/t ratio and the percentage reduction in the collapsing stress for several degrees of ovality. Two of those equations will picture the serious effect thus attributed to ovality on the collapse resistance.

For ½ per cent ovality, per cent reduction = 0.4 D/t

For 2 per cent ovality, per cent reduction = 0.8 D/t

Ovality is defined as the difference between the largest and smallest diameter expressed as a percentage of the average.

In his discussion of the Jasper and Sullivan paper, Prof. Stewart stated that his own attempt to evaluate the effect of out-of-roundness was abandoned, as it was found that the axis of the oval of one section was at an angle of widely varying magnitude with the axis at a closely adjacent section, the one thus acting to support the other.

In his paper Stewart stated that "the slight out-of-roundness of the tubes tested was the chief factor in determining the place of collapse." As Jasper and Sullivan found a very important effect of ovality from Stewart's data, they have been carefully checked by the writer and reproduced in Fig. 2. The figure bears out Stewart's statement. The careful wording led to an examination of the test data for a comparison with the test results of the entire series. Table 2 presents the important items of the comparison.

TABLE 2—Comparison of the ratio, test pressure to formula pressure, for pipe failing with the axis of collapse on the smallest diameter with the like ratio for all tabulated tests.

	Average ratio	Coefficient variation	Range
29 specimens failing with axis on the smallest diameter.	1.0287	6.4%	0.9047 to 1.1464
188 specimens of the tabulated data...	0.9909	11.1%	0.5750 to 1.247

The examination of Stewart's data relating to the effect of ovality uncovered two tests that had an extreme difference in test collapse pressure when the formula pressures, as well as other related details, were closely the same. As an illustration of the puzzle that remained unsolved for many years, the data are reproduced in Table 3.

TABLE 3—Unexplained test results.

	Test No. 244	Test No. 255
Test collapse pressure, lb. per sq. in.	1750	790
Formula (B) pressure, lb. per sq. in.	1403	1375
Ratio test to calculated	1.247	0.575
D/t ratio	31.08	31.85
Yield strength, lb. per sq. in.	41710	42990
Ovality, per cent	1.337	1.000
Wall variation, per cent	13.43	10.06

The data presented by Jasper and Sullivan cannot be used to investigate the stress curves in the plastic range for Fig. 1, but are sufficient to check, at least approximately, the elastic stress curve 1 of that figure. The comparison of the three sets of data are shown in Table 4 on the basis of the value C of formula (2).

TABLE 4—Value determined from test data presented in the appendix 3 of the Jasper and Sullivan paper.

$$C = \frac{2E}{(1-\mu^2)} = P(D/t)^3 \quad . \quad . \quad (6)$$

	C average	C range	Coefficient of variation
Stewart's tests, 28 pipe	50.77×10^6	$(42.66 \text{ to } 58.28) 10^6$	8.10%
Carman's tests, 21 pipe	65.61×10^6	$(47.02 \text{ to } 75.44) 10^6$	11.73%
Author's tests, 14 pipe	67.96×10^6	$(56.64 \text{ to } 79.84) 10^6$	9.61%

In discussion of the Jasper and Sullivan paper, R. G. Sturm credited the authors with having pointed out that "there are two distinct limitations upon the strength of thin shells under external pressure. One is that of purely elastic instability and the other is that of instability resulting from plastic yielding of that material of which the shell is made." Continuing he said, "Between these two cases lies the range which can not be figured by formulas for either case." Jasper and Sullivan, in their closure, said they "have not been able to adjust themselves" to the term plastic yield. "It is believed that at or below the appropriate curves shown for a steel of definite physical properties and with definite dimensions of a tube no plastic action is possible in the material."

It is not easy to comprehend why neither the Jasper and Sullivan paper nor the discussions made any reference to the earlier work of Engesser[3], von Karmen[4], Westergaard[5], and others, showing that the theory of elastic buckling of a straight bar can be extended to cover the case of plastic buckling.

Their paper has not been credited with its value as an incentive to renewed effort to solve the unexplained range of collapse test results. The paper posed the problem by inferring that if the pipe were true to form and dimensions the curves of Fig. 1 would check test results within a range too narrow to be worth mentioning. The questioning of some of the ideas by examination of the data presented in the two papers by Stewart and Jasper and Sullivan is, perhaps, due quite as much to this implication as to the purpose to present the problem that the manufacturer of pipe for well casing was compelled to face.

Following the presentation of the Jasper and Sullivan paper, the published record is a blank for several years. The research division of National Tube Company was occupied in an endeavor to find a better fit to collapse test data on seamless pipe than Stewart's SS formula. The pipe tested, when of the same nominal dimensions, varied in the measured D/t ratio. It was necessary to eliminate this variation in order to correctly evaluate test results. A great deal of time was spent developing a technique for producing accurate stress-strain curves. The requirement set was that the data should plot a smooth curve to an elongation scale of 1:1000 and a stress scale of 1:10,000. We were convinced by this work that collapse resistance was closely related to stress-strain characteristics.

A method for using the stress-strain curves was to calculate the expected collapse pressure by using the stress as measured on the curves, in Birnie's formula, the stress being at the point where the total strain was:

$$e/ \quad = \frac{0.943 \ (D/t - 1)}{(D/t)^3} \quad . \quad . \quad (7)$$

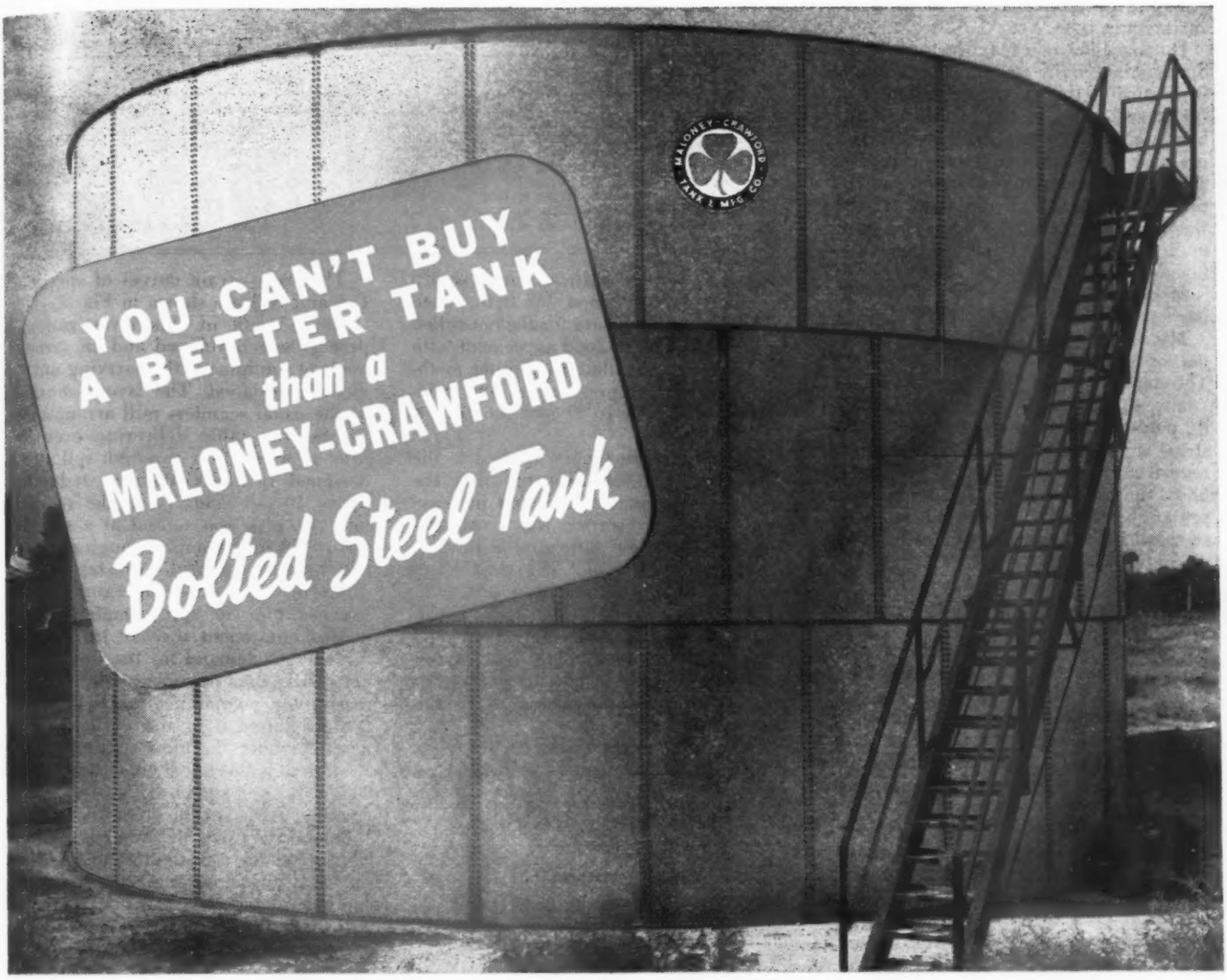
Tests made in groups of four were expected to have test collapse pressures within the range of 83 to 107 per cent of the calculated pressure. It was realized that there was no logical basis for the use of the total strain, but its use gave better results than any other method that had been tried.

A wide variation was found among the stress-strain curves of what was assumed to be identical material. This difference is illustrated in Fig. 5. In the figure, four curves selected from a large number are adjusted to a common yield

[3] Z. Arch. Ing. Wesen S (1889). 455.

[4] "Untersuchungen uber Knickfertigkert Forschungsarb it n," ZVDI 81 (1910).

[5] "Strength of Steel Columns," H. M. Westergaard and W. R. Osgood. *ASME Transactions* (1928).



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strength as a means for showing the variation in type.

During 1935 one manufacturer introduced high yield casing. The collapse resistance of this product was based on the stress curves of the Jasper and Sullivan paper of 1931. The transverse compression yield strength was specified as 80,000 lb. per sq. in. minimum for D/t ratios less than 25. This yield strength was obtained by cold work. The minimum tensiles of the material prior to forming the pipe were:

Minimum tensile strength—80,000 lb. per sq. in.

Minimum yield strength—50,000 lb. per sq. in.

The tabulated collapsing pressure for 7-in. x 0.332-in. x 24-lb. casing is 5810 lb. per sq. in. By the Lamé formula the stress is 64,260 lb. per sq. in. The stress read from the curve is 64,400 lb. per sq. in, ± the reading error. The SS formula pressure for 80,000 lb. per sq. in. yield strength is 5918, or 1.85 per cent above the high yield figure.

The possibility of so material an increase in collapse resistance by cold working induced the manufacturers of oil country goods to undertake a program of investigation. The cold rolling method for cold working had the advantage over the cold pressing method, used by this manufacturer, of adding materially to the longitudinal tensile properties as compared with the pressing method, and involved a smaller cost for both equipment and operation.

The results of tests of both methods when applied to seamless pipe were erratic. In general, the average collapse was lower than the Jasper and Sullivan stress curves indicated, and the spread much wider than for the hot rolled seamless product. A typical result is shown in Table 5.

The agreement between the pressures calculated by the Stewart SS formula and the Jasper and Sullivan curves shown in Fig. 1 is very good for both specimens. The test pressure for the hot-rolled specimen is also in good agreement with the pressures calculated by either method. But the test pressure of the cold-worked specimen is 29 per cent under the expectation.

TABLE 5

Heat No. 4180 — Carbon 0.29 per cent — Manganese 1.35 per cent

	Specimen G-6	Specimen G-5
Class	Seamless hot-rolled	Cold-reduced 7.1 per cent
D/t	22.51	21.80
Test collapse pressure, lb. per sq. in.	3,925	4,580
Stewart SS Formula P, lb. per sq. in.	4,112	6,025
P from Jasper and Sullivan Curves, Fig. 1, lb. per sq. in.	4,190	5,910
Tensile properties:		
Stress at 0.001 per cent offset, lb. per sq. in.	31,600	35,000
Stress at 0.010 per cent offset, lb. per sq. in.	41,700	52,700
Stress at 0.200 per cent offset, lb. per sq. in.	57,300	85,700

The total strain theory applied to the stress-strain curves indicated that the failure to obtain the expected increase in collapse resistance was probably caused by the low ratio of the proportional limit to the 0.2 per cent offset yield stress. This surmise gave a new direction to the investigation. It was learned that a suitable combination of steel qualities, amount of cold work, and a heat treatment following the cold work greatly improved the character of the stress-strain curves.

An example of one of the earlier trials of the process gave results in Table 6.

TABLE 6

Heat No. 2349 — Manganese 0.95 per cent
Carbon 0.37 per cent — D/t=21.01

Cold reduced 5.88 per cent then heated to 620°F.

	Specimen N-2
Test collapse pressure, lb. per sq. in.	6,230
Stewart SS Formula P, lb. per sq. in.	5,920
P from Jasper & Sullivan Curves Fig. 1, lb. per sq. in.	5,890
Stress at 0.001 per cent offset, lb. per sq. in.	61,600
Stress at 0.010 per cent offset, lb. per sq. in.	73,400
Stress at 0.2 per cent offset, lb. per sq. in.	81,600

The stress-strain curves of specimens G-5 and N-2 are shown in Fig. 4.

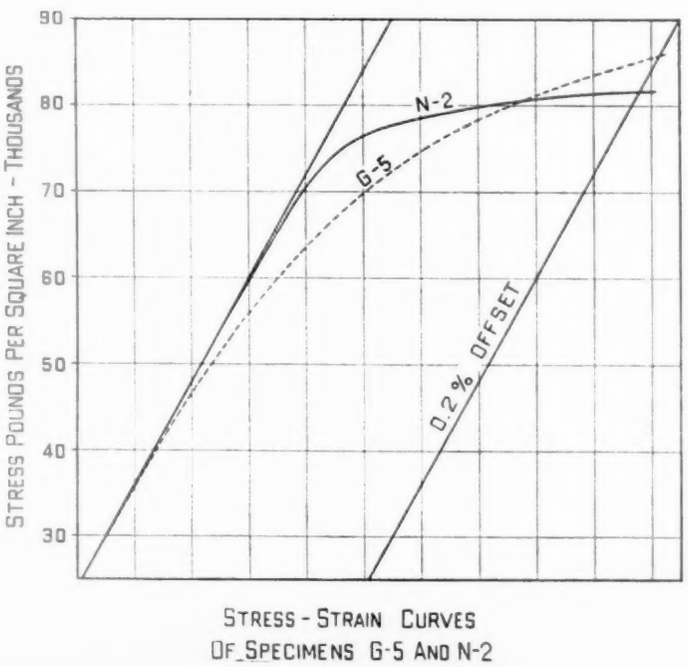
As a result of this investigation, a process was developed and an arrangement of equipment for carrying out the method designed. The layout consisted of the usual seamless mill arrangement, the cooling table delivering over-sized pipe to a series of two-high roll stands designed to effect diameter reductions up to 10 per cent. From the reducing mill the pipe was moved at a speed of about 150 ft. per min. through an induction heating coil with adjustable power input to raise the temperature of the heaviest pipe to approximately 900°F.

This equipment was not installed, as the current demand for the product did not justify the investment cost. A second reason for postponing installation was the development of the carbon-manganese-molybdenum alloy casing having a minimum specified yield strength of 80,000 lb. per sq. in. This alloy grade, meeting API specifications for Grade N-80 and the Code 5-C-2 collapse values, has served for well depths up to 12,000 ft. and answered for much greater depths.

During the war, extensive drilling in deep territory increased the use of the N-80 grade of casing. This came at a time of serious alloy shortage. The situation promised to continue as the exhaustion of oil reserves indicated increased drilling depths. The situation promised an increasing field of use for the seamless work hardening process. Development work had continued after postponing the installation planned.

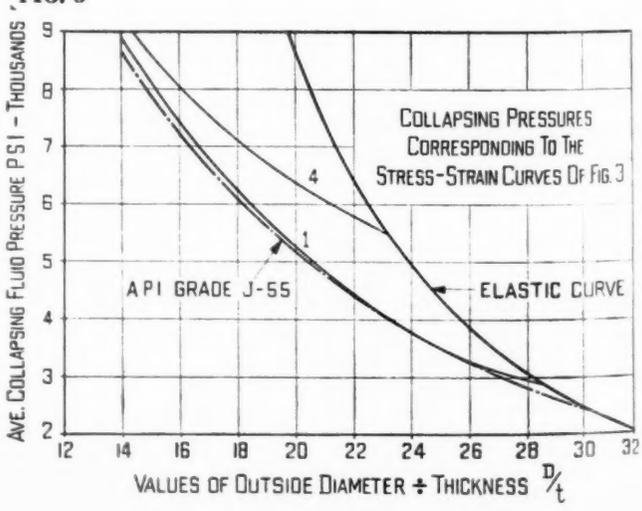
A new tool had come into use for the study of the resistance of pipe to external fluid pressure. This new tool was

FIG. 4

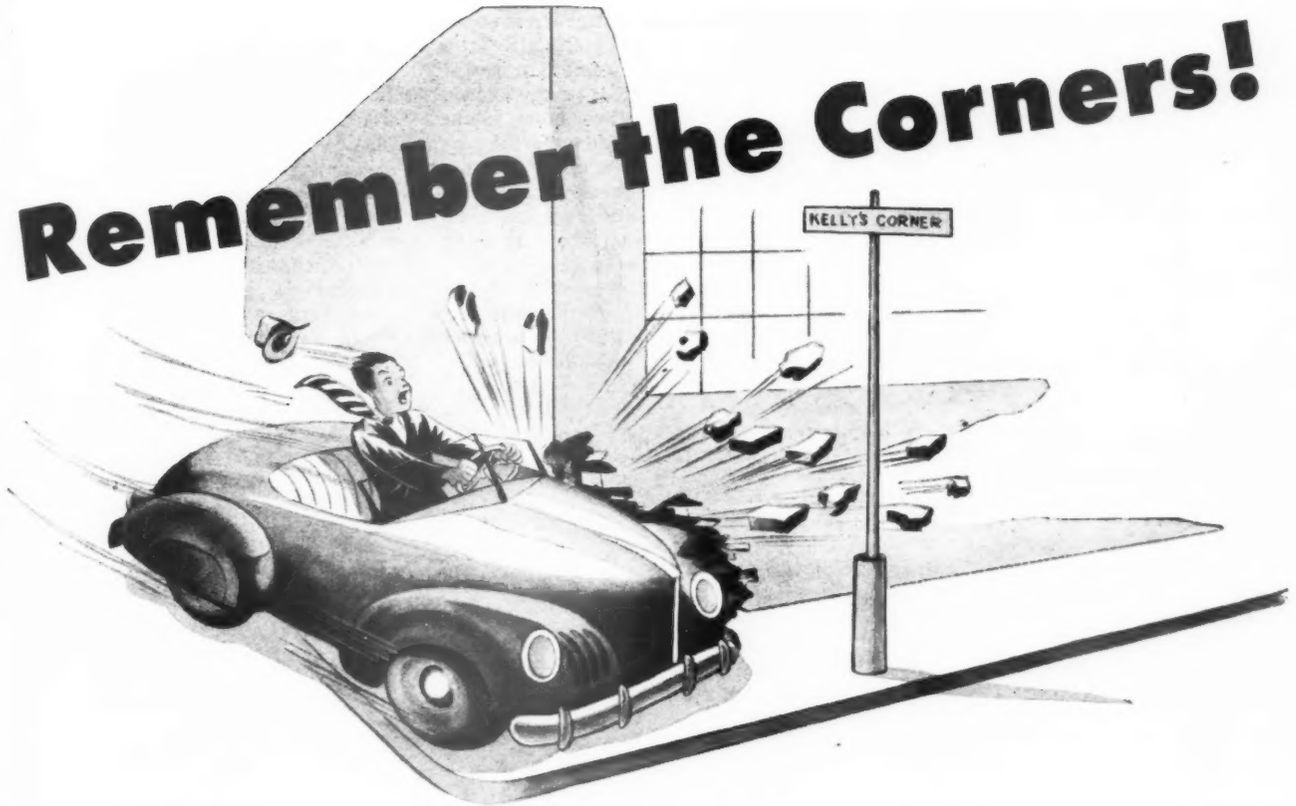


STRESS - STRAIN CURVES OF SPECIMENS G-5 AND N-2

FIG. 5



Remember the Corners!



NO DRIVER CUTS A CORNER unless his car whips out of control. No Kelly corner dashes holes in casing unless it is allowed to whip. Both accidents occur because someone forgot how far corners stick out.

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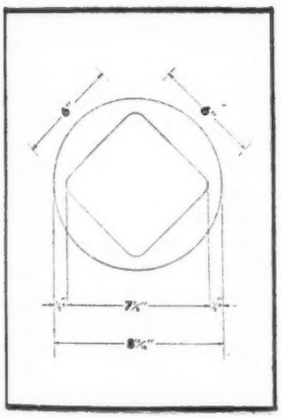


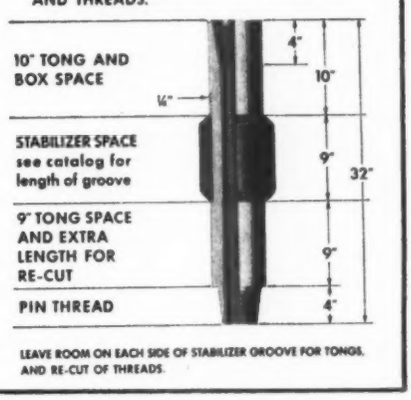
Installation dimensions of a Stabilizer, Code: MIMOSA.

"REMEMBER THE CORNERS" for complete protection. Every Kelly corner should always be protected by at least ½ inch of rubber. For example, the greatest diagonal distance between the corners of a 6 inch square Kelly is 7⅞ inches. This requires a Stabilizer 8⅜" O.D. when installed to give ½ inch of rubber protection on opposite corners. The Patterson-Ballagh Stabilizer, code: MIMOSA, having an 8 15/16" installed O.D. would be recommended in this case, assuming that the Kelly sub has a diameter of 7¾" and is grooved to 7¼".

Always use a Stabilizer with at least 1 inch greater installed O.D. than the longest diagonal dimension across the corners.

SECTIONAL VIEW OF KELLY SUB WITH PATTERSON-BALLAGH STABILIZER

SUGGESTED MINIMUM DIMENSIONS FOR KELLY SUB AND ALLOWANCES FOR TONGS AND THREADS.



LEAVE ROOM ON EACH SIDE OF STABILIZER GROOVE FOR TONGS AND RE-CUT OF THREADS.

The drawing above shows suggested minimum dimensions for Kelly sub Stabilizer installations. Patterson-Ballagh engineers have designed, specified, and coded Stabilizers and Protectors for over 700 possible combinations of Kelly and casing sizes now in use. Your Patterson-Ballagh man will give you complete information for getting the *longest wear and best results in your set up*. Proper Kelly stabilization pays big dividends.

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brought to the attention of the pipe industry by A. Nadai[6], who afterward presented a mathematical discussion of the subject in a paper jointly with J. L. Holmquist before the American Petroleum Institute. A simplification of Nadai's formulae made to facilitate calculations is sufficiently accurate for many purposes. The simplified expressions are:

$$P = \frac{2\,E'}{(1-\mu^2)\,(D/t)^3} \quad . \quad . \quad . \quad . \quad (8)$$

$$E' = \frac{4\,E_1\,E}{(\sqrt{E_1}+\sqrt{E})^2} \quad . \quad . \quad . \quad . \quad (9)$$

$$P = \frac{2\,\sigma}{D/t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

E_1 is the slope of the stress-strain curve at a given stress.

E^1 is the reduced or equivalent modulus. The relation (9) holds for pipe under external pressure. Equation (8) covers the entire stress range.

These equations made it possible to discriminate between the results of two collapse tests with a precision far greater than was possible by any of the methods used previously.

As an illustration of the use of these equations, and the dominating effect of the type of the stress-strain curve on the resistance of pipe to external pressure, the method is applied to the curves of Fig. 3 as shown in Fig. 5. The slope of the stress-strain curve is measured at a selected stress. The equivalent modulus is calculated by (9) and the D/t ratio for the stress by (10). The critical collapsing pressure is then determined by (8). Thus, a point is established on a line relating the D/t ratio to the critical collapsing pressure.

Fig. 5 shows the critical collapse pressure D/t relation for stress-strain curves 1 and 4 of Fig. 3. As the yield strength of these curves was placed arbitrarily at 65.000 lb. per sq. in., which is the value assigned to the yield strength of API Grade J-55 by Code 5-C-2, the critical collapse curve for that grade was drawn in for comparison.

It is evident from Fig. 5 that it is useless to investigate any suspected cause for the variation in collapse resistance without first eliminating the enormous effect of differences in the stress-strain characteristics of the materials. It is also evident that a characteristic stress-strain relation is inherent in any expression relating collapse resistance to the pipe dimensions. This dictates the procedure for the evaluation of the collapse resistance of a pipe product class. The procedure is to determine by a statistical analysis the relation of the collapsing pressures to the nominal pipe dimensions for a sufficiently large number of test results on suitably selected specimens, together with the standard deviation of the test data. A practical form for expressing the results is that used in API Code 5-C-2 with an added factor expressing the probable expectation.

For failure at stress in the plastic range:

$$P = (1 \pm n\,q_1)\left(\frac{a}{D/t} - b\right). \quad (11)$$

For failure at stress in the elastic range:

$$P = (1 \pm n\,q_2)\frac{c}{(D/t)^3} \quad . \quad . \quad . \quad (12)$$

n q is a multiple of the coefficient of variation.

a, b, and c are experimental constants.

The above described procedure was used in the further development of work hardening methods for the increase of the resistance of seamless pipe to external pressure.

It has been found that, at a temperature suited to the material, the effect, whatever the action might be, on the stress-strain curve was practically instantaneous. This led to the idea that possibly the teaching of the literature, that the effect of work hardening at temperatures above blue heat decreased and disappeared at the lower critical point, might not hold throughout the temperature range. Experiment established the idea to be a fact and also that such temperatures are effective in having an aging effect on the material hardened by being worked in such range. The original plan for work hardening was modified accordingly. Instead of delivering the pipe to a cooling table from the hot sizing operation, it is charged directly to a continuous furnace in which the temperature of the pipe is equalized and brought to the required level. From the equalizing furnace the pipe passes directly through the multiple stand reducing mill, and thence to the cooling table. The layout of the equipment provides for alternate lines of travel, one bypassing the work hardening process, and the other delivering the pipe from the hot sizing operation to a cooling table on which the temperature is reduced below the lower critical point. It is then charged to a continuous normalizing furnace, and from that furnace to the temperature equalizing furnace, then through the reducing mill.

The advantage resulting from the improved process is the extension of the range of the possible combinations of the physicals of the hot-rolled pipe, diameter reduction, and temperature at which the reduction is effected. The range of the properties for a steel class and constant diameter reduction at several temperatures are shown in Table 7.

The tensile properties prior to work hardening are the average of 12 tests. The collapse results of the work hardened pipe are the average of six tests at each temperature level corrected to the average ratio D/t = 21.15. The tensile properties are the average of two tests from each collapse test.

The process has been in production for the past six months, under a system of quality control insuring maintenance of the standards set. Up to the first of the year, 561 collapse tests were recorded on the product. The coefficient of variation for the entire number was 6.79 per cent.

It is probable that this coefficient is somewhat high, as it was observed to decrease gradually as the data were accumulated.

The test results expressed in terms of equation (11) with n = 3 are:

$$P = (1 \pm .204)\frac{252566}{D/t} - 5622 \quad (13)$$

As the dimensions of the pipe were mainly in the plastic stress range, the constants for equation (12) have not been determined. The question here is the experimental values for Young's and Poisson's constants.

It should be obvious that the process has great flexibility. By varying the chemistry, temperature, and amount of reduction, grades of higher or lower collapse resistance are produced.

In concluding this review of the effort made to find a solution of the economic problem presented by the drilling of deep wells as it relates to the resistance of pipe to external pressure, the hope is expressed that omission of the major portion of the many contributions made to the subject may not detract too seriously from the purpose of directing attention to the value of careful planning of an experimental investigation. The mathematical solution of the problem of unstable equilibrium preceded Stewart's experimental investigation. Today, the application of statistical methods for planning experimental work and evaluating the test results are too frequently neglected. Hit and miss methods may ultimately obtain results. Some of it is necessary, but it is both time-consuming and costly. ★★★

[6] "A Theoretical and Experimental Approach to the Problem of Collapse of Deep Well Casing," J. L. Holmquist and A. Nadai. *API Drilling and Production Practice*, 1939.

TABLE 7—Warm work results—5.36 per cent reduction.

Temperature of reduction	Yield strength	Elongation, per cent in 2-in.	Collapse pressure	Increase in collapse over hot-rolled, per cent
Atmosphere	92,080	24.0	5,883	39.25
500°F.	112,420	15.9	6,931	64.04
650°F.	108,500	16.3	6,973	65.04
850°F.	98,120	19.2	6,738	59.48
970°F.	82,550	22.9	6,133	45.16

Chemistry and hot-rolled physical properties:

Heat No.	12846
Carbon, per cent	0.41
Manganese, per cent	1.06
Phosphorus, per cent	0.015
Sulphur, per cent	0.020
Silicon, per cent	0.180
Yield strength, lb. per sq. in.	58,400
Ultimate strength, lb. per sq. in.	102,600
Elongation in 2-in., per cent	26.5
Collapse pressure at D/t=21.15, lb. per sq. in.	4,225

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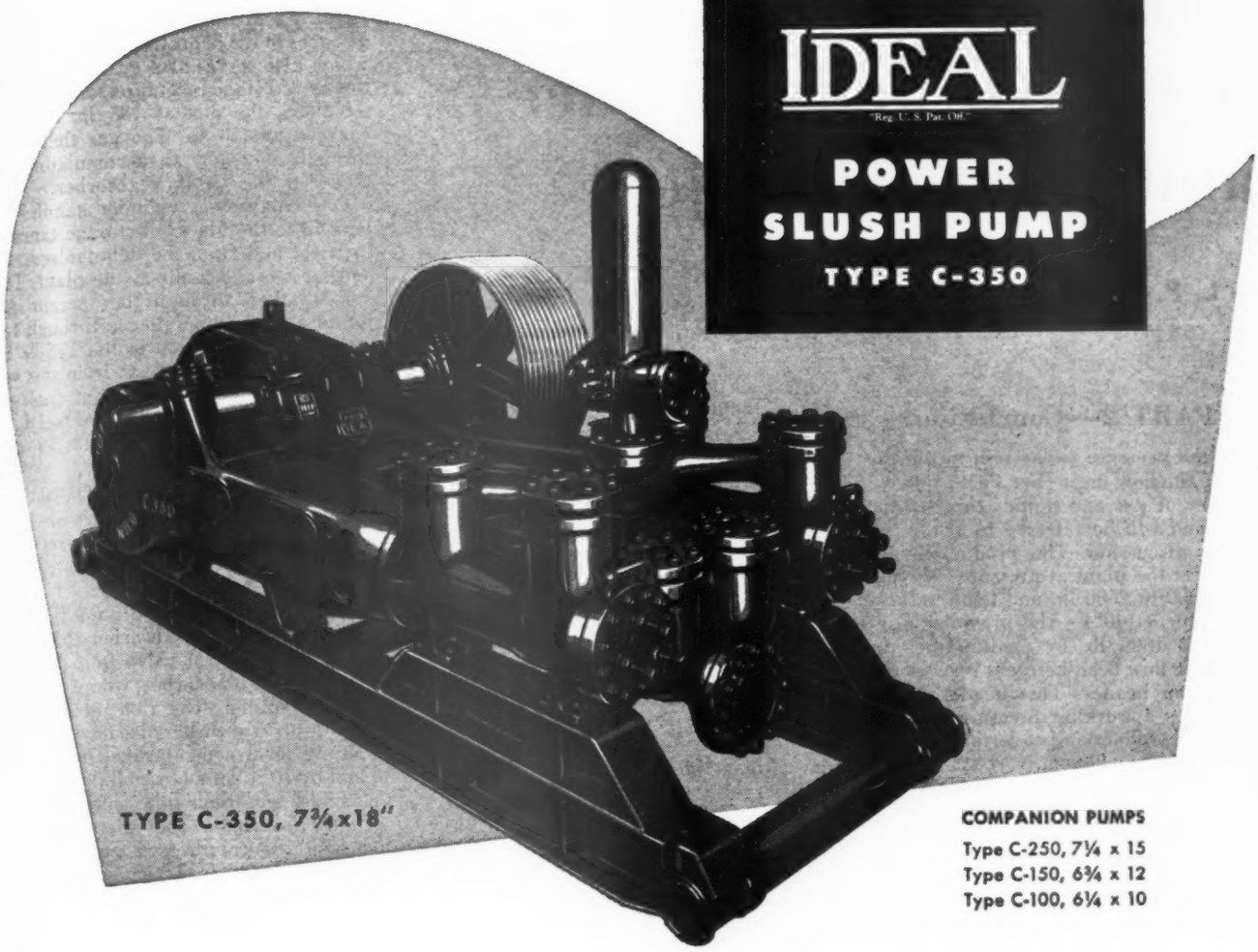

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PART 2—Conclusion

● **High pressure gas system within the plant.** The flow sheet (See Part 1) shows the flow of gas and liquids through the plant and will be referred to in the following discussion. The production gas arrives at the plant at pressures varying from 1800 to 2600 lb. and temperatures from 110 to 140°F. The pressure is reduced to 1800 lb. by passing the gas through a flow bean before it reaches the production header. This header is designed for a working pressure of 3000 lb. In the production header all the condensate wells' effluent is commingled. The gas and liquid then flows through a pressure reducing regulator, which is controlled by the pressure in the 1500-lb. absorber residue scrubber. The purpose of this regulation valve is to reduce the pressure to 1500 lb. and hold a constant pressure on the high pressure absorption system. After passing the pressure reducing valve, the gas flows through cooling coils where the temperature is reduced to 90°F. From the coolers the gas flows to the high pressure gas separator, which is 54 in. in diameter by 15 ft. high, with a design working pressure of 1600 lb. The liquid continues into the fractionation system, which will be discussed later. The gas from the 1500-lb. separator flows directly to the high pressure absorber, which is 66 in. diam. by 75 ft. high, having a shell thickness of 3-7/16 in. This vessel has 30 trays on 24-in. centers. Here the gas is contacted with sufficient absorption oil to get the desired recovery of the heavier hydrocarbons. The gas then flows into the high pressure residue scrubber before going to the second stage repressure compressors. The high pressure absorber residue scrubber is equipped with a mist extractor, high liquid level alarm, and a high liquid level shutdown switch to ground the magnetos on the compressors. Any liquid carryover from the high pressure absorber is thus prevented from reaching the compressor cylinders. This feature is also installed on all compressor suction scrubbers. After leaving the high pressure compressor cylinders the gas is cooled from 225 to 165°F., and is returned to the sand through five injection wells. A check valve is installed in the injection line near the plant to prevent any back flow of gas from the injection line should this system fail in the plant. The compressors are installed to deliver 54,500,000 cu. ft. per day of absorber residue gas to the injection system at 4000 lb. The eight installed compressor services vary in suction pressures from 6 in. vacuum to 1500 lb. and in discharge pressures from 30 lb. to 4000 lb.

● **Black oil production gas.** Gas from the black oil production is brought to the plant at three different pressures; namely, 450 lb., 60 lb., and 6 in. vacuum. The 450-lb. black oil gas flows to the 450-lb. separator where it commingles with the condensate flash gas. The mixed gas stream flows into a high pressure reabsorber, which is 60 in. diam. by 63 ft. high, with 24 trays on 24-in. centers. The bottom section of this vessel is used as a 450-lb. flash tank for the rich oil from the base of the high pressure absorber. In this vessel, the combined gas stream is contacted with the required absorption oil. The gas then flows to the 450-lb. reabsorber residue scrubber before going to the first stage repressure compressors, which have a suction pressure of 430 lb. and discharge pressure of 1510 lb. From here the gas flows through a cooling coil where the temperature is reduced from 275 to 90°F., and thence to the high pressure absorber residue scrubber. Here it is mixed with the residue gas from the high pressure absorber.

The 60-lb. black oil gas flows into the 60-lb. trap as does the condensate from the 450-lb. trap. Here the 60-lb. black oil gas is commingled with the flash vapors from the 60-lb. condensate. This 60-lb. trap also serves as the liquid charge tank for the crude debutanizer column. From here the gas flows to the first stage of the low pressure gas compressor and is compressed to 180 lb. The gas is again boosted, aftercooled, and flows through a final accumulator to the 450-lb. reabsorber. To complete the compressor services, the fixed gases from the stripper reflux accumulator, the hot rich oil vent tank, and the crude rectifier reflux accumulator are commingled. These three gases are at approximately the same pressure, which renders them suitable for one compressor service. The first stage recompressor picks up the combined three streams at 70 lb. and discharges at 190 lb. Before this gas enters the cooler, the overhead liquids from the stripper and crude rectifier are blended with this gas for the sponge effect. From this cooler, the liquid and gas goes to the depropanizer charge tank, which also serves as a gas separator for the second stage recompressor. This service takes the gas at 185 lb. and discharges at 450 lb. The gas then flows through a cooler, an accumulator, and thence to the 450-lb. reabsorber.

One compressor cylinder handles vapors from the black oil storage tanks in the field and from the debutanized condensate storage tanks at the plant. This gas is taken through the vacuum gas liquid accumulator, thence through two stages of compression to the 175-lb. reabsorber. The residue gas from this vessel flows directly to the plant fuel system. The 175-lb. reabsorber vessel is 36 in. diam. by 38 ft. high, and has 16 trays on 18-in. centers.

● **Absorption oil system.** The flow of lean oil from the high pressure absorber has been discussed in the two preceding sections, but to clarify this point, it will be reviewed briefly.

The rich absorption oil flows from the base of the 1500-lb. absorber through a liquid level control valve into the base of the 450-lb. reabsorber, where the flash gas is liberated. The rich oil from the base of this reabsorber also flows through a liquid level control valve into a 5-ft. diam. by 10-ft. long horizontal flash tank. The flash gas then flows into the base of the 175-ft. reabsorber where it is mixed with the compressed gas from the vacuum system. The rich oil from the base of this vessel also flows to the 175-lb. rich oil flash tank mentioned above. From this flash tank, the rich oil flows countercurrent through the absorption oil heat exchangers. Here the temperature of the rich oil is increased from 95 to 404°F. The oil then flows to the hot rich oil flash tank. The liquid leaving this vessel flows to the fired heater where the temperature is increased to 500°F. The hot rich oil then flows to the stripper where the absorbed material is stripped from the oil. The hot lean oil then flows through the absorption oil exchangers where the temperature is reduced from 482 to 137°F.; then through the lean oil coolers for final cooling to 80°F. From here, the oil flows to the lean oil surge tank, which is 10 ft. diam. by 30 ft. long. This surge tank allows approximately 20 min. detention time for any entrained water to settle. The 270 gal. per min. of lean oil is pumped to the 1500-lb. absorber with three 3½ by 12 horizontal duplex outside packed plunger pumps. Each pump is driven by a 4-cylinder 185-hp., 4-cycle natural gas engine. The size of these pumps was selected and the pumps geared to the engines in such a ratio that any two pumps can deliver the required quantity of lean absorption oil at rated engine speed. The lean oil for the 450-lb. and 175-lb. reabsorbers is pumped with a turbine-driven, 6-stage, centrifugal pump. There are two identical pumps and turbines for this service, either one of which can supply the required 230 gal. per min. of oil.

The stripper column operates at 85 lb. From the bottom of this column is

*Presented before the California Natural Gasoline Association, July 2, 1946.

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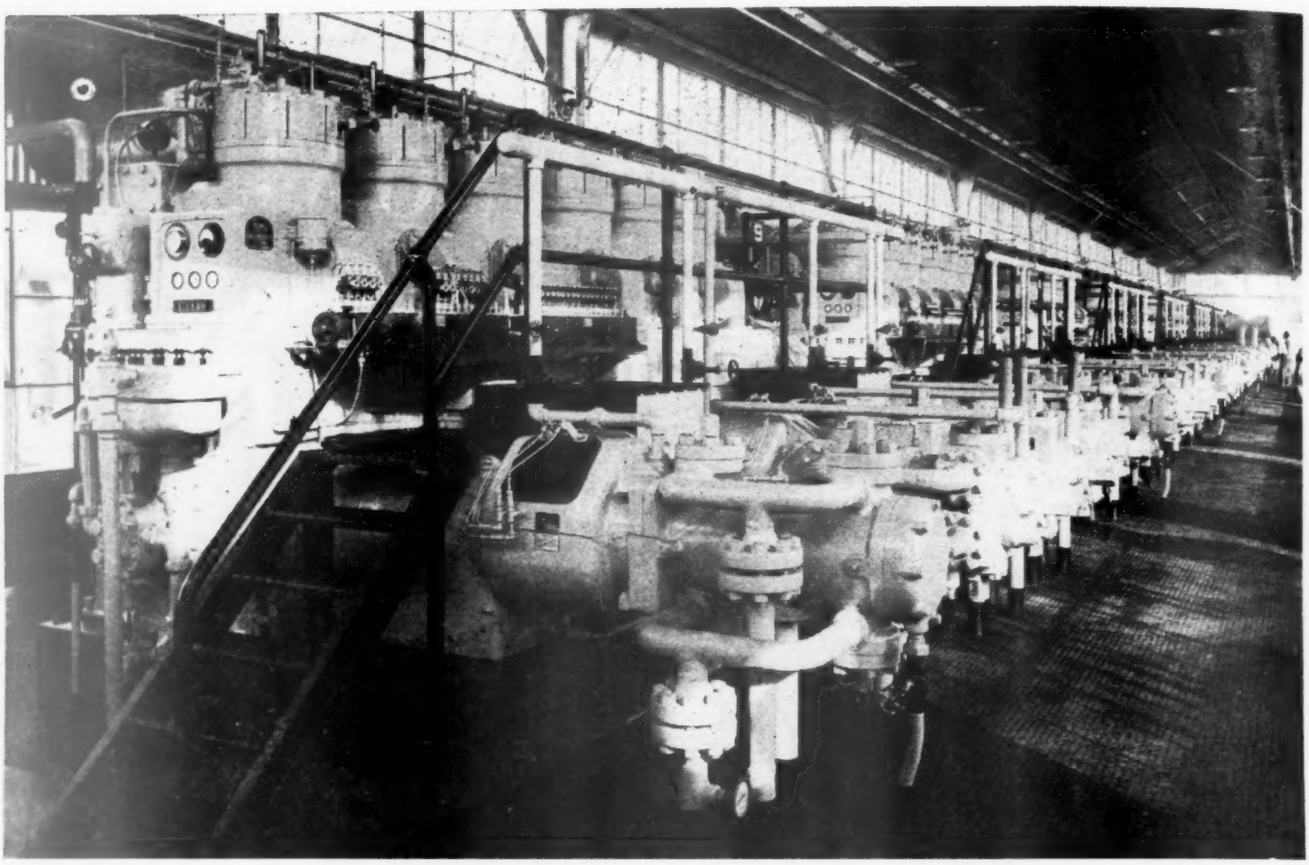


Inside the compressor house are nine 600-hp., 2-cycle, gas-engine-driven compressors, each having four compressor cylinders and engaged in two or more services.

drawn a lean oil with a relatively low vapor pressure. The overhead product is raw natural gasoline. To meet the two above requirements, all the internal reflux that reaches the first tray above the feed is drawn from the stripper. The stripper is 66 in. diam. by 52 ft. high, and has 20 trays. There are eight trays on 18-in. centers in the rectifying section and 12 trays on 24-in. centers in the stripping section.

The side-draw stream from the stripper is charged to the fractionator. This feed consists principally of light absorption oil with some heavy gasoline and kerosine. In this column, three cuts are taken: Stripped absorption oil out the bottom, kerosine from a side-draw, and natural gasoline overhead. The fractionator operates at 5 lb. It is 36 in. diam. by 63 ft. high, and has 24 trays at 18-in. centers. There are 13 trays in the rectifying section and 11 trays in the stripping section. Four of the trays in the stripping section are below the internal heater. The kerosine side-draw connections are on the 7th, 9th, 11th, and 13th trays from the top. This type of fractionator operation has been successful in eliminating the light ends and controlling the vapor pressure of the lean oil.

The total absorption oil circulation rate is approximately 500 gal. per min. The make up oil to the system is 80 gal. per day. The heavy ends picked up in the absorbers is 600 gal. per day.

An oil reclaimer is used to control the end point of the absorption oil. This vessel is situated beside the stripper. The feed to the reclaimer is from 3 to 5 gal. per min., and taken from the 13th tray from the top of the stripper. The rate of feed in controlled by a liquid level controller on the reclaimer. All the process steam used in the stripper first passes through the reclaimer. The partial pressure effect of the steam vaporizes the light ends and carries them back to the stripper. The heavy ends of the absorption oil accumulate in the reclaimer and are dumped periodically. This system has proved satisfactory for end point control.

● **Fractionation system.** The raw condensate from the high pressure production gas is pumped from the 60-lb. trap into the crude debutanizer column through feed to bottoms exchangers. Here the temperature of the feed is increased from 97 to 250°F. From the base of this column, the debutanized condensate is drawn through the reboiler, heat exchanger, cooler, and thence to storage. The overhead vapors from this vessel are condensed and pumped into the recompressor interstage discharge line ahead of the cooler. Here they are blended with the condensable overhead product from the stripper. These two liquid streams, along with the non-condensables, then flow to the depropanizer charge tank. The liquid is then pumped with a close clearance simplex pump to the depronpanizer column through the feed to the bottoms exchangers. The charge rate to this column is controlled by a flow controller that regulates the steam to the charge pump. The depropanzier operates at 350 lb. From this vessel the propane and lighter fractions are taken overhead and the condensables are pumped to the injection wells. Fixed gases are burned in the boilers and heater. For propane injection, a 22 by 4½ by 20 simplex outside packed plunger type pump is used. It is operated on 300 lb. saturated steam and the discharge pressure is 3750 lb. For the recovery of propane, the depropanizer column is arranged with sidedraw connections on the 3rd, 5th, and 8th trays from the top. The depropanized liquid flows from the base of this column through the reboiler and bottoms to feed exchangers. From these exchangers the liquid passes through the debutanizer bottoms to feed exchangers to the debutanizer column. This column operates at 150 lb. Natural gasoline is drawn from the base of the debutanizer through the reboiler, heat exchanger, cooler, and thence to storage. The butanes are taken overhead, condensed and charged to the butane splitter column. The butane splitter operates at 115 lb., is 66 in. diam. by 112 ft. high, and has 65 trays on 18-in. centers. The isobutane is passed overhead, condensed, and the net make sub-cooled before going to storage. The normal butane is drawn from the base of the column through the reboiler, cooler, and then to storage.

● **Steam generating plant.** The steam requirements for the plant are 52,000 lb. per hr. Steam is generated in two 800-hp. boilers. The boilers operate at 300 lb., are of the water-tube type, equip-

ped with induced draft fans and have air-cooled settings. The boiler steam pressure controller operates a pressure reducing valve in the fuel line. The induced draft fans are driven by steam turbines running at constant speed. Draft is controlled automatically and varies with fuel requirements and pressure differential across the tubes in the fire box. The steam balance is adjusted so there is a minimum of 300-lb. steam reduced through the pressure reducing valves for processing. Practically all the process steam is first used in the turbines or the reciprocating pumps. The turbine drivers of the 450-lb. lean oil pumps operate on 300-lb. inlet and 100-lb. exhaust steam pressures. This 100-lb. steam is used in the reboilers and for process stripping. All the reciprocating steam pumps operate on 300-lb. steam and exhaust into the 25-lb. oily steam system. The oily steam is consumed in the butane splitter reboiler and the fractionator column. The 25-lb. oily condensate from the butane splitter reboiler is drawn to the sewer.

The water for the plant use and the boiler feed is pumped from wells on the site. The hardness of the well water is 1 grain per gal. The raw water make-up is 40 per cent of the boiler feed water. The boiler feed water treatment is of internal type. During the first six months of operation, there has been no scale formation or pitting.

● **Electric generating plant.** To have available a dependable source of plant power and to eliminate the installation of small internal-combustion engines in hazardous areas an electric generating plant was built. In the generating plant there are four 250-kw., 2300-volt, a-c. generators. These generators are driven by 8-cylinder, 4-cycle gas engines that operate at 400 r.p.m. To maintain constant speed, the fuel to each engine is controlled by a sensitive hydraulic governor. The governors have the speed droop feature. Three of the governors are set with some speed droop and one is set with no speed droop. The engine with no speed droop setting normally carries a small load. When additional load comes on the line, this engine picks it up immediately. Consequently, the low voltage period caused from additional load is short.

The main switchboard is of the metal-clad dead-front type. Leads from each generator are equipped with reverse power relays. Should an engine die, its generator is automatically disconnected from the main buss to prevent motoring. The main board is equipped with automatic sychronization, individual voltage regulators, and remote speed control.

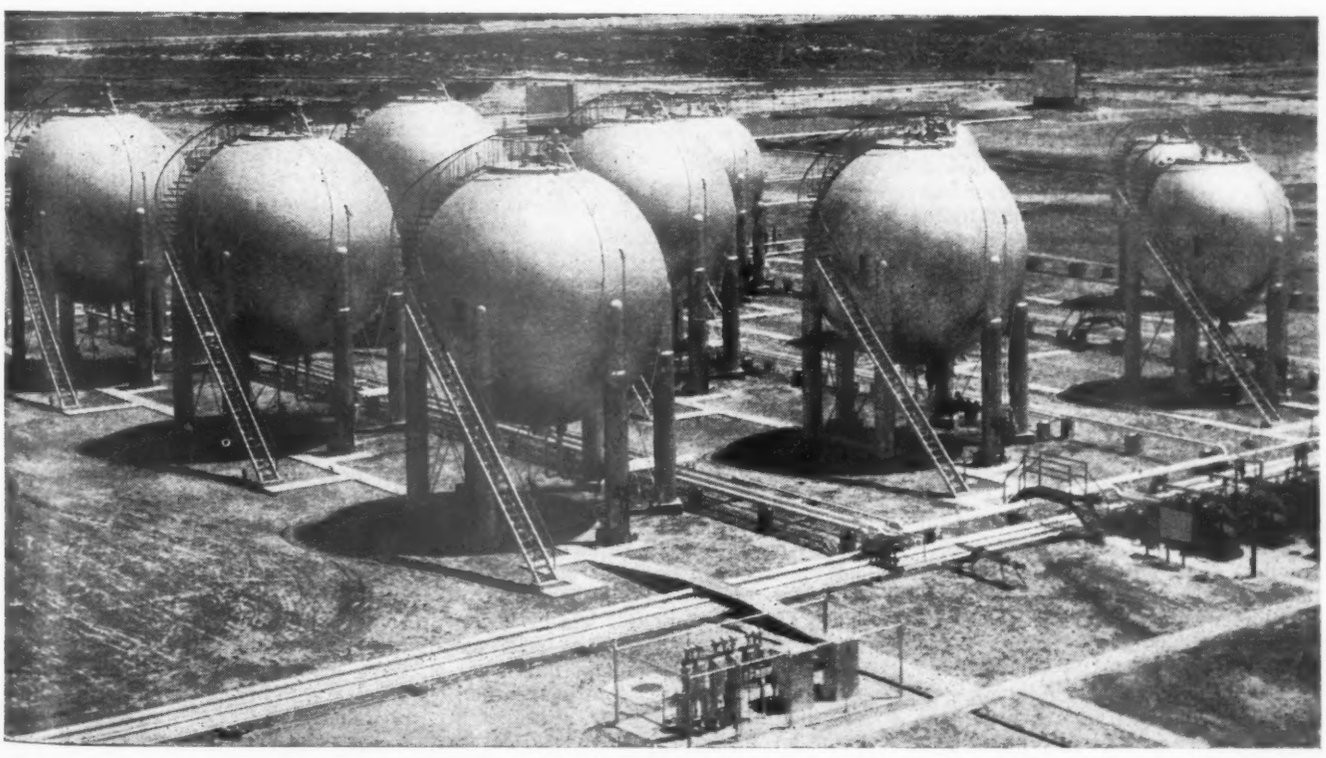
For further protection, an under-voltage relay is installed in the power circuit to the pipe-line pumps. Should the voltage drop to 2000 volts, these pumps drop off the line and do not come back until reset by hand. The generators and drivers were selected so that any three can carry the full plant load. Most of the electricity is consumed at 2300 volts by the cooling tower, jacket water, and pipe-line pump motors. The electricity is distributed through the plant at 2300 volts in underground transite conduits, which are encased in red concrete for protection and identification. All motors, 50 hp. and above, operate at 2300 volts and those less than 50 hp. operate at 440 volts. Transformers are placed throughout the plant where voltage reduction is necessary.

● **Cooling towers.** Separate atmospheric cooling towers are installed, one for jacket water cooling and one for process cooling. The jacket water cooling tower is 53 ft. high and 132 ft. long. This tower is designed to cool 5100 gal. per min. of water from 103°F. to 88°F. when the wind velocity is 1 mi. per hr. and the wet bulb 75°F. The jacket water cooling tower is used to cool the engine jacket water and the engine lubricating oil cooler water. The heat load on this tower is 38,000,000 B.t.u. per hr.

The process cooling tower is 55 ft. high and 534 ft. long and is designed to cool 9000 gal. per min. of water from 96°F. to 80°F. when the wind velocity is 1 mi. per hr. and the wet bulb 75°F. All the gas cooling coils, overhead vapor condensers, and liquid coolers handling hydrocarbon products are installed in this tower. The heat load is 70,000,000 B.t.u. per hr.

● **Compressors.** In the compressor building there are nine 600-hp. 2-cycle, gas-engine-driven compressors. Each machine has four compressor cylinders and serves two or more services. The compressor cylinders are so arranged that there are one 1500-lb. cylinder and one or more 4000-lb. cylinders on each machine. The remaining throws are fitted with low pressure cylinders. This arrangement was necessary to keep the two high pressure services in balance from a capacity standpoint. All cylinders on the power and compressor ends are porous chrome lined. All rod packing is of the metallic bronze type. The compressor piston rings are of various materials; namely, micarta, cast iron, tinized cast iron, and bronze.

Light products, namely, natural gasoline, normal butane, isobutane, and propane, are stored in spherical pressure tanks, set on legs to give necessary suction head for satisfactory pump operation.



Button head grease gun fittings are installed on the oil lines from the lubricators to the piston rod packing. Should the rod packing heat, either when breaking in or because some foreign material has lodged under the packing, the operator attaches a grease gun to the button head fitting and flushes the packing with oil. This washes out the foreign material or cools the packing. The 1500-lb. and 4000-lb. cylinders are lubricated with a compounded oil.

The most unusual part of the compressor plant, from a design standpoint, is the suction and discharge piping. There are no expansion loops in the piping. The concrete piers are spaced from 6 to 8 ft. apart and the pipe is securely fastened to each pier with special type clamps. The direction of the pipe movement determines the type of clamp used. There are three types of clamps installed, first, the anchor type, which is used to fasten the pipe rigidly to the anchor pier and does not allow movement in any direction; second, the linear expansion type, which allows the pipe to move longitudinally only, and is identical with the anchor type except that the tie-down bolts on one side are spring loaded; and third, the box type, which is a rectangular clamp with the anchor bolts spring loaded on one side to allow both longitudinal and lateral movement of the pipe.

All headers, both suction and discharge, which run the full lenth of the compressor building, are securely anchored at the midpoint. As the temperature of the suction and discharge streams increases, these lines are forced to expand both ways from the anchor point. All other clamps on the headers are of the box type to allow the pipe to move longitudinally with temperature change and laterally as the lead-in and lead-out lines expand or contract. The box type clamps are also used on the compressor suction and discharge lines between the compressor building and the headers. Where a line changes direction, the box type clamps are used on the first two piers on either side of the corner.

Pipe vibrations in the 4000-lb. and 1500-lb. discharge lines have never been apparent. This was accomplished by the incorporation of five separate ideas in the design of the compressor piping:

1. The elimination of expansion loops by using the special pipe clamps.

2. Short pier spacing to keep all heavy valves and blind flanges close to supports.

3. Large suction and discharge lines which result in low gas velocities of from 5 to 6 ft. per sec. in the high pressure discharge lines.

4. Large suction and discharge chambers located close to the compression cylinders. The following chamber volumes were used (all volumes are stated as cylinder volumes): 1500-lb. suction, 19 volumes; 4000-lb. discharge, 19 volumes; 450-lb. suction, 12 volumes, and the 1500-lb. discharge, 12 volumes.

5. The installation of a patented type pulsation dampener on all cylinders discharging at 1500 lb. and 4000 lb. One pulsation dampener takes care of from one to three cylinders depending upon how the cylinders are manifolded.

It is quite apparent that at high suction and discharge pressures supercompressibility must be considered when calculating the volumetric efficiencies of the compressor cylinders. This is illustrated by the following data, which are based on calculations and actual observations:

Comparison of calculated and actual cylinder capacities at 1500-lb. suction and 3750-lb. discharge

	Metered quantity at suction conditions. (Supercompressibility considered in calculating orifice coefficient)	Calculated quantities		
		Supercompressibility considered 1. To calculate cylinder volumetric efficiency 2. To make allowance at suction conditions	Supercompressibility considered only at suction conditions	Conventional method. (No supercompressibility considered)
M. cu. ft. per day	39,450	40,760*	36,000	29,435
Per cent of metered quantity	100.0	103.5	91.2	74.3

*Calculations made by using the method developed by Robert S. Ridgway, Standard Oil Company of California, presented before the California Natural Gasoline Association in Los Angeles, March 1, 1945.

● **Storage.** The light products; namely, natural gasoline, normal butane, isobutane, and propane, are stored in spherical pressure tanks. The debutanized condensate is stored in atmospheric pressure cone-roofed tanks. The legs on the spheres are extended, placing the bottom of the tanks 9 ft. above the top of the foundations or approximately 11 ft. above the ground. This added elevation gives the necessary suction head for satisfactory pump operation. The legs of the spheres are insulated with magnesia blocks and covered with galvanized iron for fire protection. Each sphere is equipped with a ground reading gauge. There is sufficient storage to hold six days' plant production.

The plant products are shipped to the participating companies by either tank trucks or pipe lines. There are four pipe lines serving the plant.

● **Test separator area.** All the lines from the production wells enter the plant at one point near the southeast corner. Here the gas from each well flows through its orifice meter, steam jacketed heater, flow bean, check valve, and into the production header. The well effluent is metered at full wellhead pressure. The test separator header is manifolded to all the production lines. After entering the test separator header, the gas and liquid flow through cooling coils and to the 1500-lb. test separator where the gas passes overhead through an orifice meter and enters the 1500-lb. wet gas stream going to the high pressure absorber. The retrograde liquid or raw condensate is drawn from the base of this separator through a liquid level control valve. This liquid is then flashed in the 450-lb. test separator. The flash gas passes overhead through an orifice meter and continues to the 450-lb. reabsorber. The liquid is again drawn through a liquid level control valve and flashed in the 60-lb. test separator. From this vessel the 60-lb. flash gas passes through an orifice meter and continues on with the 60-lb. black oil gas to the plant. The 60-lb. trap is a horizontal vessel, 7 ft. diam. by 30 ft. long, with sufficient capacity to hold the raw condensate make from any well for a period of from 12 to 24 hours.

To check a gas-oil ratio the full production gas stream from a well is diverted through the test separator unit. The outlet temperature of the gas from the cooling coils is held constant for all tests. Volumes are recorded and gravities on the three gas streams are taken. The liquid is accumulated and measured in the 60-lb. trap. From these figures a gas-oil ratio and per cent water cut is determined. Low temperature fractional distillations are run on a liquid and gas sample from each producing well. To eliminate running a separate analysis on each of the three gas streams, a composite gas sample is taken. This composite sample is taken in absolute pressure increments proportional to the volume of each stream. By holding the final absolute pressure in the sample bomb below 300 lb. the effect of supercompressibility is small. A sample of 60-lb. liquid is taken and analyzed. The result of the two analyses are combined to determine the composition of the well effluent.

Gas-oil ratio are run on all production wells once each month. Fractional analyses were run on the effluent from each production well shortly after the plant started operating. These analyses are now run only when there is a change in a well's gas-oil ratio.

● **Emergency shut-down system.** The plant is equipped with two emergency shut-down systems; namely, primary and secondary. There are five shut-down stations throughout the plant from which the shut-down systems can be operated. Air pressure of 25 lb. is maintained on these systems. The diaphragm or piston operated shut-down valves actuated by this system are made to operate by reducing the air pressure on the system. The two bleed valves at each of the five shut-down stations are equipped with cams so that the primary system is always made to operate first. Then, if necessary, the secondary system can be operated.

The primary system performs the fol-

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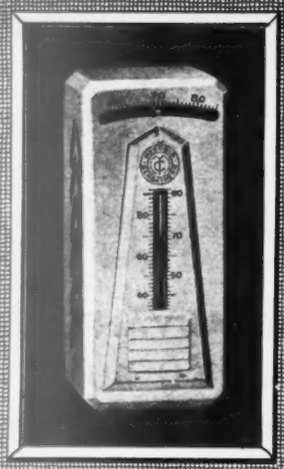

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lowing operations on the processing equipment:

1—Shuts off all incoming gas to the plant except auxiliary fuel.

2—Shuts down the gas compressor engines and all lean oil pumps.

3—Shuts off the fuel gas to the rich oil heater and purges the fire box with steam.

4—Bleeds down the pressure on all 4000-lb., 1500-lb., and 450-lb. gas lines in the plant, including the 1500-lb. absorber and the 450-lb. reabsorber.

The secondary system performs the following operations on the utility equipment:

1—Shuts off the fuel supply to the steam boilers and purges the fire boxes with steam.

2—Shuts down the electric generator engines.

The above two systems are used for emergency shut-down only.

● **Fire fighting system.** Each debutanized condensate storage tank is connected by a 4-in. pipe line to a permanent foam generating plant. The foam generating plant is situated on the plant fire line and at a safe distance from the tanks.

Water for fire fighting purposes is supplied throughout the plant in an underground gridiron type system. Throughout the system, block valves are placed so any section of the line can be taken out of service without rendering the rest of the system inoperative. The fire pump is a turbine-driven centrifugal type with a capacity of 750 gal. per min. at 150-lb. pressure. This pump is automatic in operation. A 1-in. line from the 60-lb. utility water system maintains pressure on the fire system. Whenever a fire hydrant is opened and the pressure in the fire system drops below 40 lb., the fire pump comes on and maintains 150 lb. on the system until it is shut off and reset by hand.

A gas-engine-driven turbine pump is installed in one of the two water wells for starting up, fire fighting, and standby purposes. This pump will deliver 500 gal. of water per min. at 150-lb. pressure. The gas supply to this engine is independent of the plant.

Portable fire extinguishers are placed at convenient points throughout the plant.

● **Contractor.** The contractor in charge of the construction of the South Coles Levee Cycling Plant was The Fluor Corporation, Ltd., of Los Angeles, California.

Comment by Robt. S. Ridgway, Standard Oil Company of California:

The compressor requirement for the South Coles Levee plant covers seven services, with pressures ranging from 6-in. vacuum to an expected 4000-lb. pressure. These include field gas and plant vapors. Of these seven services, the 400 to 1500 lb. and the 1500 to 4000 lb. were of sufficiently high pressure to involve appreciable deviation from Boyle's Law. For this particular problem, the analysis of the effect of supercompressibility on compressor capacity and horsepower was developed and later, on March 1, 1945, presented to this body. Applying the results of this study it was found that the power requirement for the low stage could be reduced by 90 hp. from the 1420 hp. calculated under conventional methods. For the high stage, 560 hp. could be cut from the 3460 hp. conventionally calculated. This made a total of 650 hp. by which the installation could be reduced if we were to recognize "deviation" and apply it properly to compressor operation. The total power required for all services when carrying the injection pressure to 4000 lb., under Boyle's Law calculations, amounted to 5850 b. hp. We had elected to use 600-hp. units and by this method of computation we would have needed 10 such. With 650-hp. subtracted from this figure, nine units would provide ample horsepower, and for this reason we purchased only nine machines.

At the time the quotations for compressor equipment were requested, we were particularly careful to require the manufacturers to calculate the cylinder sizes from the supercompressibility methods we had developed. Curves were provided to each supplier showing the increase in cylinder capacity that could be expected with variations in cylinder clearance, for the various pressure ranges. Foote's figure shows the close agreement that was obtained between the calculated capacity and the metered figure. The 3½ per cent discrepancy shown was probably due to ring and valve losses. The agreement on the 400 to 1500-lb. stage was even closer than on the high stage, the metered figures being less than 1 per cent different from the capacity computed when recognizing supercompressibility.

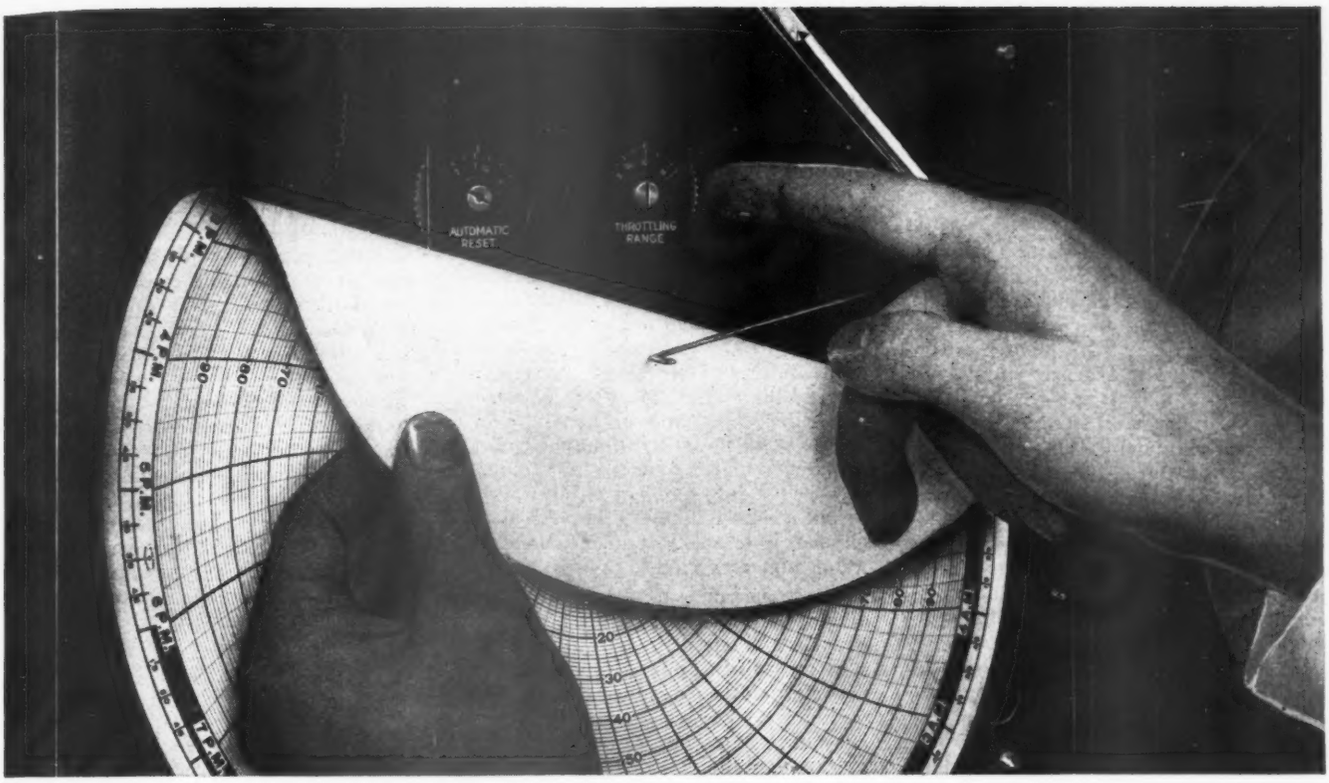
As well as saving ourselves a whole 600-hp. unit, we further saved ourselves probable trouble due to overloads, by recognizing "deviation" when providing cylinder capacity. The figure shows that under conventional methods, the capacity provided would only be expected to handle 74.3 per cent of the volume being metered. Had we provided for full capacity under conventional methods, we would have handled 1/0.743 or 134.5 per cent of the expected volume, and the cylinders handling this gas would have had a corresponding overload. Inasmuch as five of our units are equipped with one low and three high stage cylinders, such an overload would doubtless have demanded that we take immediate steps to reduce it. This would have been expensive, and would have come at a time when such alterations were at least inconvenient.

Foote's figure is an excellent illustration of the fact that the supercompressibility correction to compressor performance cannot be broken into parts, and one of them neglected. The whole correction must be made.

★ ★ ★

Editor's note: This is the second and concluding part of Mr. Foote's article on South Coles Levee.

They told us to run this "AD"



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BROWN *Air-o-Line* FLOW CONTROLLERS

Outstanding Performance With Simplicity

Pipe line dispatcher

By **RICHARD SNEDDON,** *Pacific Coast Editor*

EXCLUSIVE

Of the diverse operations that are correlated and integrated to streamline the functioning of the petroleum industry, none is more vital to ultimate success than effective and efficient pipe line transportation. The movement of crude oil from its source to refinery or shipboard seems on the surface to be rather a simple process, but in reality, it becomes so involved by regulations and restrictions, all quite necessary, that the responsibilities of the pipe line superintendent and his aides are magnified in proportion and complexity beyond any semblance of simplicity.

Every day in California there are gathered into rundown tanks, treating systems, and field storage, some 850,000 bbl. of crude oil, produced by approximately 23,000 wells, situated in widely scattered productive areas. When this preliminary gathering has been accomplished, and the pertinent accounting data has been acquired, the oil is then pumped through trunk lines to refineries for the manufacture of a great variety of products, or to nearby marine terminals for shipment to other ports. Some of it may even, in the form of refined products, be returned to tank farm or other field storage, pending final disposition.

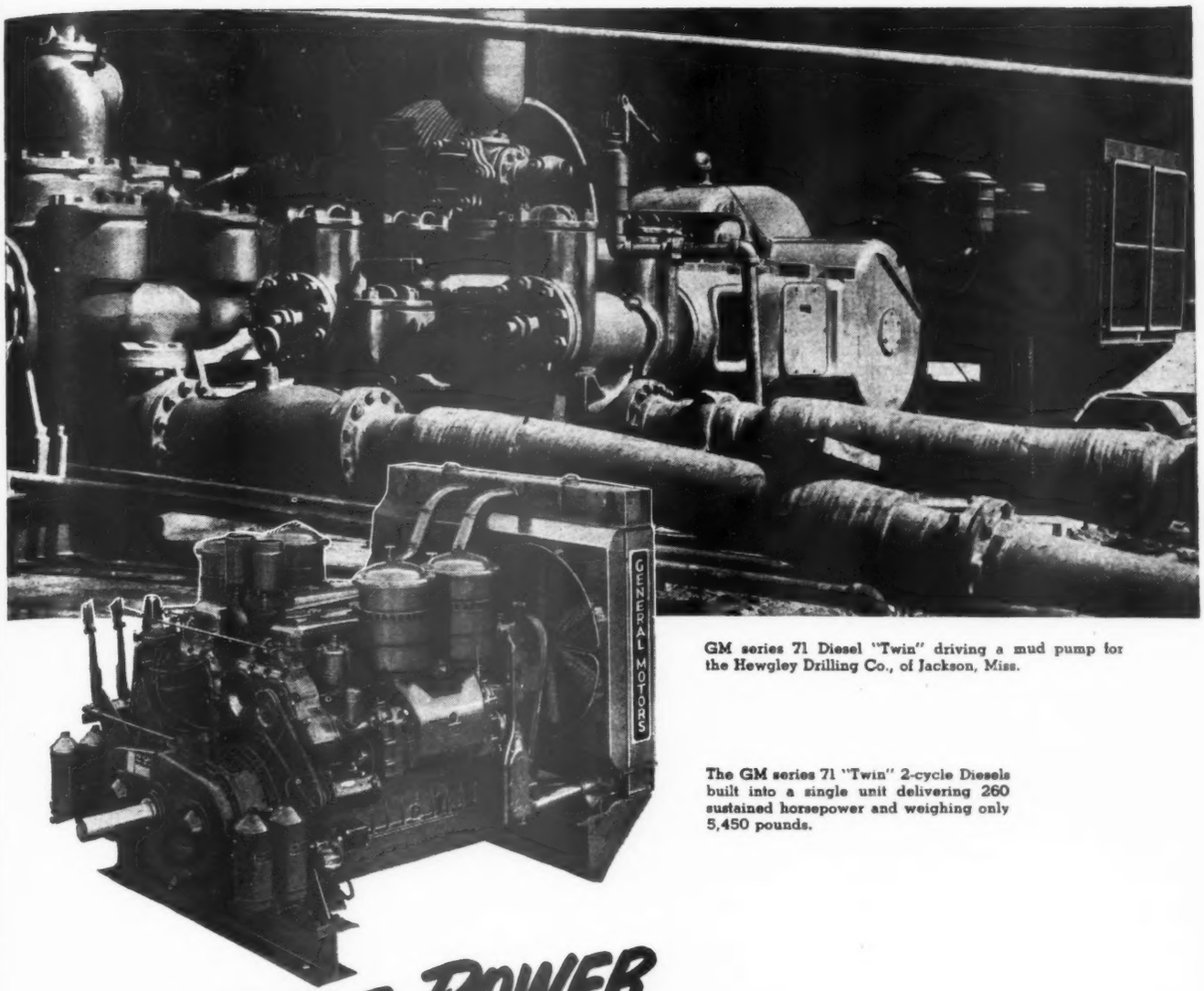
Through an underground network of pipes, rivers of oil flow silently and ceaselessly, their direction, and, indeed, their every movement guided and controlled by a small but exceedingly industrious group of individuals known as dispatchers. For 24 hours each day, these oil dispatchers, like their brothers the train dispatchers, are engaged in transmitting endless orders and receiving endless reports. The voice of the dispatcher is familiar to many field men who have never actually seen him in person. He is in many respects a unique person, who completely reverses the adage about little boys being seen and not heard, by being constantly heard but rarely seen.

Oil dispatching, as performed today in a large producing and refining organization, is a comprehensive process that involves a multitude of operations, carried out with clocklike precision and demanding exactitude. Yet, so far as we know, there is no place where one may learn to become a dispatcher, except in a dispatcher's office. It helps, of course, to have been employed in the pipe line department, and to be familiar with pumps and line pressures, run-tickets, and gauges. It helps to have been engaged in oil transportation accounting, and to know something of the art of balancing receipts and deliveries. It might even help to have put in a year or two at the information desk of a metropolitan railway station, but there is just no particular experience or hard and fast set of qualifications by which the embryo dispatcher may be successfully judged. In fact, the only sure way to tell whether or not a man is likely to be a good dispatcher is to make him one, and then watch him very closely.

The main functions of this obscure individual are to transmit to the pipe line gaugers and engineers all orders for the starting up of pumps, the opening and closing of valves, the observation of line pressures, and the accumulation of a miscellany of significant data relating to receipts and deliveries of oil. Even without knowledge of the detail incident to these activities, and the many additional chores that fall to the lot of the dispatcher, it will be easy to imagine that his working life is by no means one of quiet serenity. In reality, he lives a hectic sort of existence that could only be enjoyed by a person with an imperturbable disposition, a fast acting cerebrum, a ready understanding of complex operation, and a pair of sturdy tonsils.

A discussion of a well organized dispatching system as conducted by one large western producing and refining company, should be of interest to pipe line superintendents of other companies, for this particular phase of operation has never been subjected to industry standardization, and in fact has so far even escaped the attentions of technological analysts and efficiency experts. Perhaps, however, in order to set the stage for a rational dissertation, it might first be advisable to mention briefly some of the elementary but important incidentals. To begin with, since all transactions are on a volumetric basis, the capacity of every vessel, used even temporarily for the storage of oil, is determined prior to its use by strapping engineers, so-called from the simple fact that they use a strap tape to acquire most of the essential measurements for their volumetric computations. The process is completely mathematical and takes cognizance not only of the internal dimensions of the shell, but of the supports, inside pipe connections, and other impedimen-

Dispatcher is seen at "the board" plugging in to indicate a closed valve. Each valve bears a number that is registered on the board as well as the gaugers' district maps, so there is little chance for misunderstanding of orders. Pipe lines carrying various commodities are indicated on the maps in different colors.



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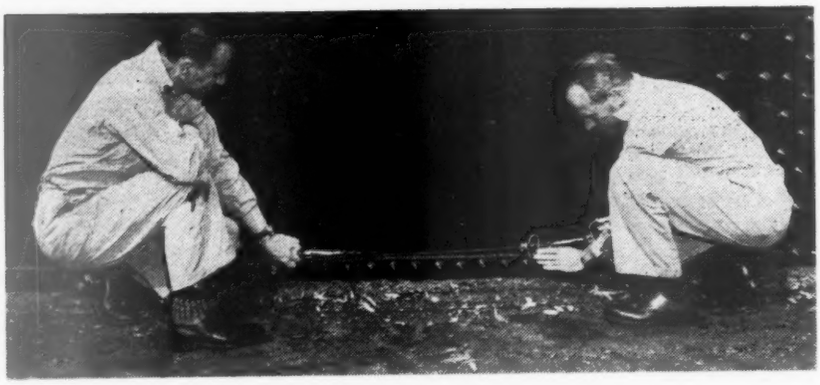


When strapping a tank the measuring tape gives correct reading at a recommended tension. Above engineers make a circumference reading with spring grips registering the proper pull.

ta that displace fluid and hence affect the cubical content. For each tank on the pipe line system, a gauge table is computed, showing the capacity in barrels for every eighth or quarter inch from the bottom up, and the limiting height to which the tank may be filled. Copies of all such tables are supplied to the dispatching department, and copies of the tables for the tanks in his particular district are given to each gauger.

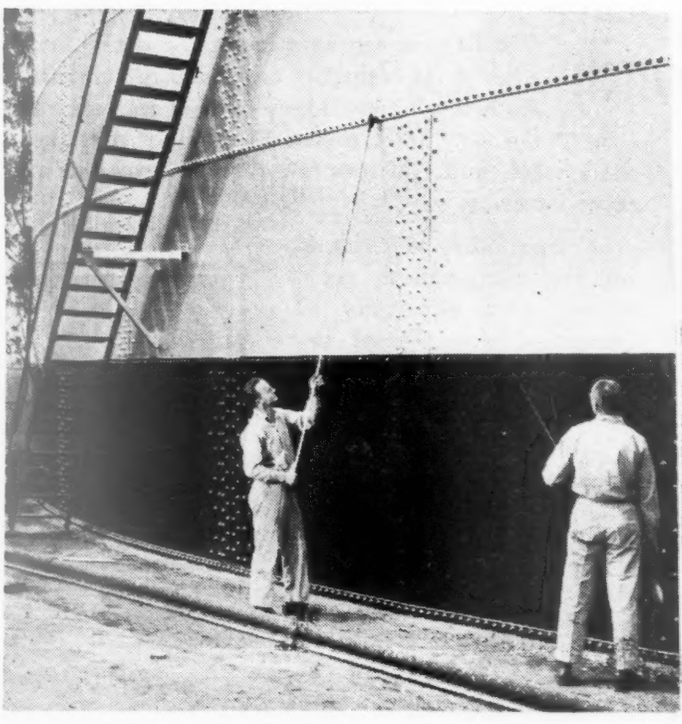
Capacities are also calculated and recorded for any lines that are likely to be involved in the alternate pumping of different types of crude, or of crude and refined products. This is to eliminate the possibility of error in hasty calculations, for transposition of figures in volume factors, or a mistake even in multiplication, may very easily spoil an entire operation. Line capacities are always established between significant points, extremities being designated by numbered valves, so that the most complicated movement can be completed without resort to anything but the simplest arithmetic, and as far as possible spot calculations are avoided by having them done in advance. These line capacities are highly essential in pipe line operations, and with the gauge tables form an important part of the dispatcher's stock in trade.

The particular system here described involves continuous operation, with a dispatcher proper on all three tours, a pipe line accountant on day tour to recapitulate the figures, and a chief dispatcher, also on day tour, to direct the operations as developed by the pipe line superintendent and transportation heads. The dispatcher has a telephone mouthpiece strapped to his chest, and a receiving instrument harnessed to his head. In front of him is that highly essential adjunct "the board," which is simply a large sized map of lines, tanks, and all accessories on the pipe lines, with innumerable tiny plugs to represent the various valves. Each valve has an identifying number, and when the plug is pegged in, the valve is closed; when it is out, the valve is open.

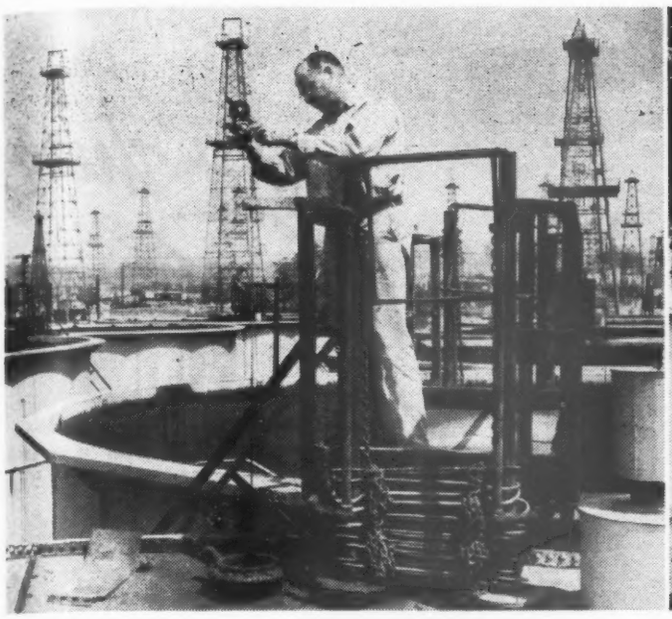
Every pipe line gauger and engineer has in his possession, a copy of that section of the map that is peculiar to his own district, with the valves correspondingly numbered, so that when the dispatcher refers to any valve by number there is no mistaking his meaning. Oil, gas, and gasoline lines all have identifying colors, both on the board and on field maps, and the whole system is so correlated and integrated that the chances of error are greatly reduced. In addition to the items mentioned, the paraphernalia of the dispatcher includes a large daily report sheet, on which are recorded quantities, line pressures, pump strokes, and other data pertinent to the oil movements under way; the "log" book that carries transcripts of all orders and acknowledgements of their execution, and finally a "dope" book that is used for notes relating to miscellaneous matters reported from the field.

Hovering constantly in the background, with his eagle eye on the report sheet, is the chief dispatcher, the anchor man of the dispatching team. His particular function is to develop, by consultation with the pipe line superintendent, what operations are scheduled for the day, and to pass the dope along to his

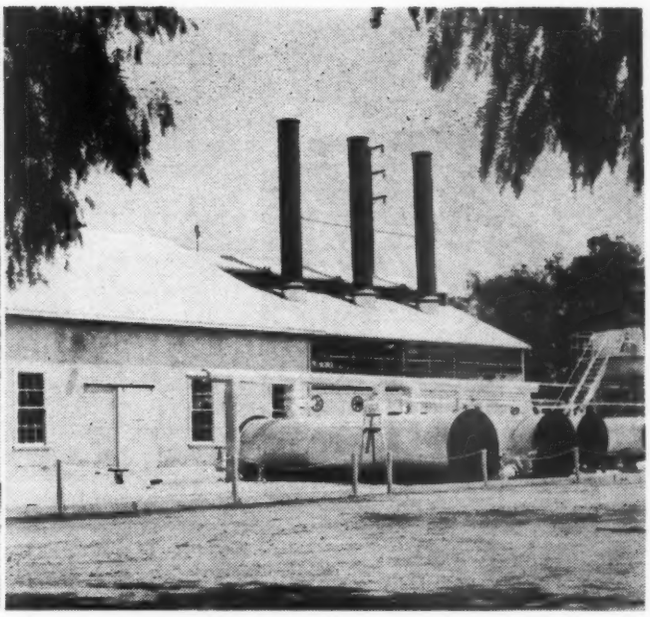
In taking measurements for preparation of gauge tables it is necessary that the tape be flat, not twisted, and that it be correctly placed. Strapping engineers here place the tape for a circumference measurement at top of the second ring.



Work reports from pipe line gangs are turned in to the dispatcher who enters them in the "dope" book for benefit of the pipe line superintendent and the time keeper.



It is gauger's duty to determine quantity and quality of oil involved in each movement to or from his district and to set the valves as ordered by the dispatcher so that such movements are properly carried out.



Typical main line pump station showing boiler stacks above and a battery of heaters below. The section to the left houses the oil pumps. The yard, not seen here, is occupied by dehydrators and steel storage.

boys. This he does, accompanying his instructions with copious references to the board, in order to insure complete understanding, and coincidentally obviate the chance of a slip-up. Each dispatcher passes the story along to his successor and takes pains to see that the man coming on tour is thoroughly appraised of all that is afoot before he is left to his own devices. As a rule, this process is not too easy, because meantime the dispatching business goes briskly ahead, and consequently instructions have to be given in between snatches of telephone conversation, which to most people is a bit disconcerting, but to a dispatcher is just normal procedure.

As might be expected, too, the pipe line schedule as of any specific time is by no means static. Operations have an exasperating way of changing suddenly, and just when all arrangements have been completed for the delivery of a commodity, through a certain line to a specific point, it may become necessary to make an altogether different sort of delivery through the same line to a quite different point. This, of course, calls for an immediate huddle between the chief and the pipe line superintendent, out of which the former emerges with a hectic rearrangement of lines and valves.

Looking now at the overall picture, when crude oil is produced at the well, it is gauged, sampled, and tested by the production department, and if sufficiently clean, that is, contains not more than 3 per cent of water and sediment, it is then ready for shipment to the pipe line. When such oil is pretty certain to be dry, the gauges and tests are made by the pipe line gauger in the presence of a field or production department representative, to avoid duplicating the procedure. If the oil is wet, it is treated by the production department, or by the producer if it is an outside purchase, to remove excess water, after which it is acceptable to the pipe line. Even then, however, there are complications, because there are many different types of crude oil, and each has its specific application in the petrolic scheme. It becomes necessary, therefore, to segregate wet crude from dry, light from heavy, asphalt from fuel oil, and in general, one class from another. These distinctions are in some degree related to source, but it is quite common to derive two entirely different types of crude from different zones in the same field, and it is quite obvious that with all these oily characteristics and eccentricities the chief dispatcher at least should be familiar, in order that the business of segregation might be better understood.

In actual operation, crude oil is ordinarily moved from run-down tanks through the gathering lines into station or tank farm storage, either by gravity or by the use of small field pumps. Thence it is relayed from one pump station to another by the large station pumps, until it reaches its destination. All such movements are under the control of the dispatcher, who is in effect the ear and the mouth of the pipe line superintendent. The centralization of control is necessary to accomplish adequate distribution of main line pumpings and so avoid dangerous pressure jumps, and at the same time perform the segregation in an orderly and systematic manner.

Suppose, now, that there is nothing unusual about the day's schedule: From the producers' tanks in every district, oil is being pumped or gravitated through gathering lines to station storage, where it is being picked up and pumped through trunk lines to the refinery. What is the routine? First, the dispatcher issues orders to all gaugers and engineers involved in the preliminary moves. These orders, designated for execution at a certain time, are entered in the log book, and must be repeated back by the recipients to make sure that they have been understood. They are reported back as completed, with the time of completion, and all this, too, is entered in the log. Each gauger turns in an estimate of the oil he will be pumping into the main line from his district, and, thereafter, puts them "on the line" as he is authorized. (The estimates will be corrected by actual gauges later). Then, every hour, from every pumping station, the dispatcher receives and records an accurate statement of the quantity of oil received at and pumped from the station. At the same time, he is supplied with an account of pumping rates, line pressures, and other relevant facts.

Meantime, he is still issuing orders and acknowledging execution notices for every succeeding step in the operation. Also, it should be remembered that crude oil is produced or purchased by his company in widely diverse areas, and that each has its separate contingent of gaugers and pumpers, receiving oil intermittently during the 24 hours of every day. Thus, the attention of the dispatcher cannot be focused on any one spot. On the contrary, all district gaugers and engineers are in the same category and are handled in the same manner, so the process just described is literally going on in a dozen places at once. By the same token, there is a maximum pressure to which each line, sometimes each section of line, may be subjected. There is a maximum capacity to which each tank may be filled. And woe betide the dispatcher who fails to note that a pressure has risen beyond the prescribed limit, or so far forgets his capacities as to permit a container to be filled beyond the preordained level! If, of course, such tragedies occur in contravention of the

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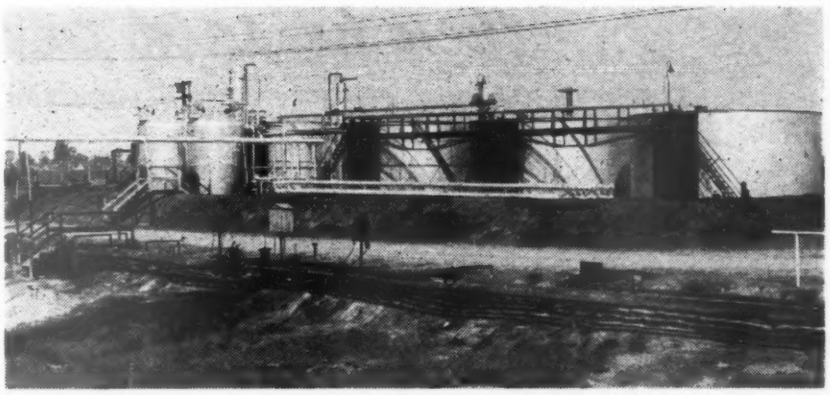
dispatcher's order, then someone else must pay the piper.

The hourly check not only provides an indication of the progress of operations, as prearranged by the pipe line superintendent and the transportation department, but is in addition a protective measure that has resulted in a totally inestimable saving of properties, facilities, and even lives. A sudden drop in pressure may mean a broken line, with oil spilling out on to the ground, perhaps in a rich residential area, thus besides the loss of oil, threatening life and property. The prompt action of the dispatcher on such occasions has frequently averted catastrophe. He knows the pressures all along the line, so can soon locate the affected section, and inform the operating superintendent, who, in turn, can take the necessary steps to avoid or at the worst limit the damage.

A sudden increase in pressure is a warning that a closed valve, or some other type of stoppage or constriction, is interfering with the passage of oil, and may result in irreparable damage to pumps and other equipment, with the possibility of a line break, if the pumps cannot be stopped in time or the stoppage removed. It is rarely, however that the causes either of sudden increases or decreases are allowed to get beyond the incipient stage. They are invariably discovered and eliminated before the effects become serious.

An interesting pipe line operation in which the dispatcher is often involved is the so-called "line clearance." This is necessary when a change is made in the kind of commodity being pumped through any particular section of line. If the change is from light to heavy oil, for example, he simply closes off the light oil supply, and starts heavy oil through the line. Because, it is a heinous offense to mix the two, however, he pumps the exact quantity of heavy oil to displace the light oil in the line. As the heavy oil fills the line, the light is discharged into its proper container, and when tank gauges show that the line is completely occupied by the new commodity, delivery may be begun into the tanks designated for the heavy oil receipt. This operation can also be checked, and frequently is, by observing the change of gravity at the discharge end of the line. Samples are drawn off at intervals and tested, until the results indicate that there is complete displacement.



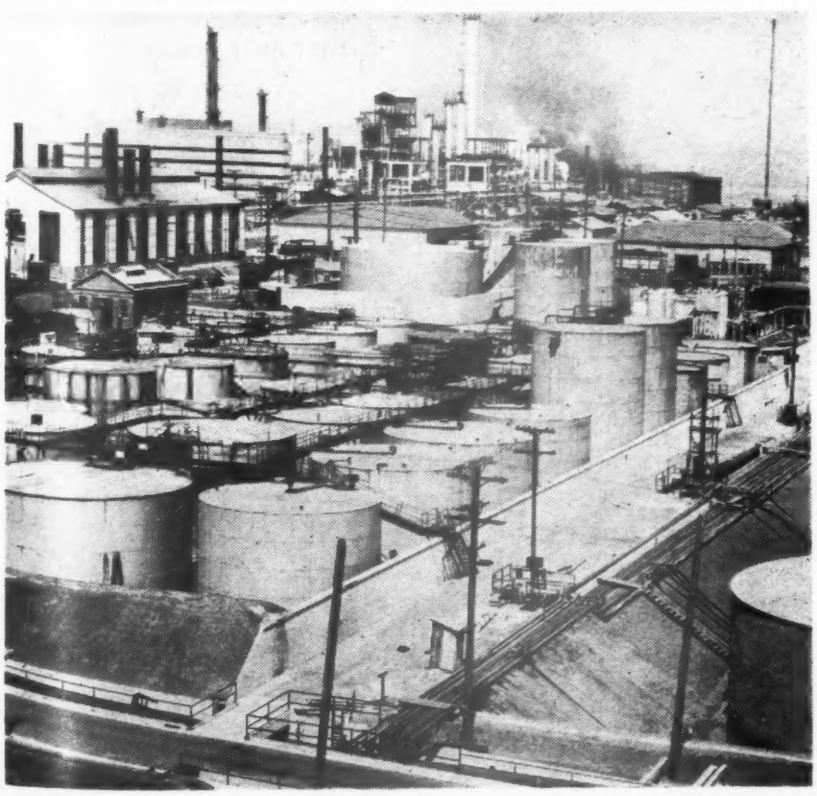
Battery of lease shipping tanks with electric dehydrators at the left. Ordinarily the pipe line gauger may not accept any oil into the line that contains more than three per cent water and sediment.

All movements of oil from lease shipping tanks, or from field storage, to ultimate receipt at refinery or terminal, are recorded hourly on the dispatcher's sheet. So, similarly, are all movements of casinghead gasoline, and such refined products as are pumped into the pipe line system. With pressure, pump stroke counts, and other pertinent data also entered on this comprehensive document, the dispatcher can tell at any time during the day or night how each operation stands—what has been done, and what remains to be done. At the conclusion of the 24-hour period, the dispatching sheet constitutes a full and detailed story of the day's transactions, from which the accountant may balance all receipts and deliveries, and the pipe line superintendent can apprise himself of many things that otherwise might take a lot of time and effort to find out.

There is no monotony in the routine. Different types of oil, and such derivatives as must be handled by the pipe line department, are each moved separately through the lines, and delivered at tank farms or terminals into its own storage container. Refineries must be supplied continuously with the required varieties of crude, in proper quantity and proportion, and in good time. Ships must be loaded promptly to provide adequate working stocks at assignment points. All the tests that are made by the pipe line gaugers, therefore, delivering to or receiving from the pipe lines, are of prime interest in the business of keeping unlike commodities apart, and like commodities moving as fast in the proper direction as is consistent with safety.

There are many incidentals. Wet oil is reduced to the permissible water content before acceptance. Viscous oil must be heated to reduce its viscosity, and so prevent the building up of prohibitive pressures during heavy oil movements. On all these matters the gauger is fully informed by the gaugers, engineers, and pumpers, and in turn relays the information to pipe line superintendents and

Keeping a modern refinery supplied with crude oil in sufficient quantity and of the right type is perhaps the biggest job of the pipe line department. It requires the closest cooperation between the two departments.



then he said to himself:

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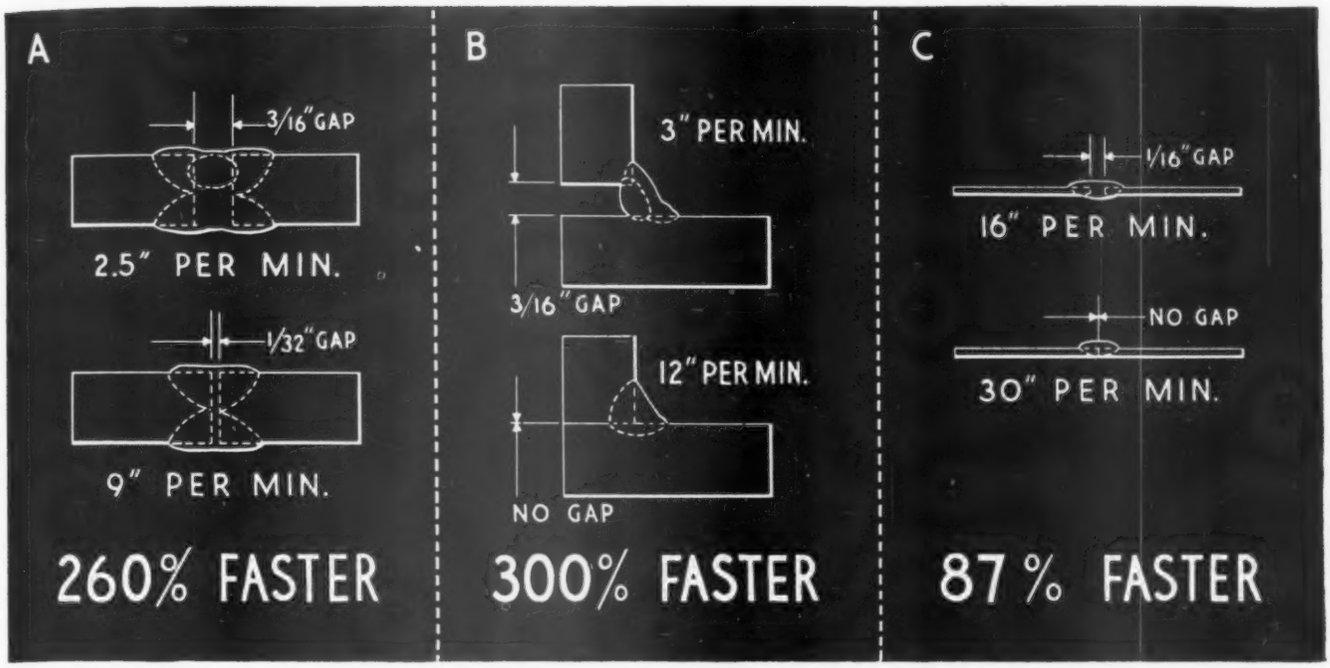

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other interested parties in the transportation department. At the end of each month, all tank farm and station storage is gauged, tested, netted, and balanced with receipts and deliveries, to determine operational gain or loss.

So far, discussion has been confined to what might be termed straight line performance, but there are compound operations that add greatly to the complexity of the pipeliners' responsibilities, and help admirably to keep them awake nights. There is, for instance, the initially simple exchange account, in which one company, for lack of convenient pipe line facilities, gives its oil to another company that has a line in the area, and then receives it back in some district where the situation is reversed. That transaction would be comparatively easy to carry out, but quite often before the deal is completed, the receiving company may make a new exchange agreement with someone else, involving the same oil, and the latest entry into the picture may make another agreement, so on *ad infinitum*. The physical exchange may thus eventually take place between two total strangers, but in the meantime, all the implicated pipeliners must keep track of all the ramifications—a job that is rather confusing to the layman, but seems to present no especial difficulty to an oil accountant.

The entire process of accounting for pipe line movements, and for storage and stocks under pipe line jurisdiction, comes to some extent under the wing of the dispatcher. Every barrel of oil received or delivered is measured and tested accurately by the pipe line gaugers. Quantities are reduced to a common basis—dry volume at 60°F.—and receipts and deliveries are then balanced. Differences must at least be explainable. Leaks, evaporation, and other causes result in losses, which, however, are reduced to an absolute minimum by the institution of every foreseeable precaution. When discrepancies are not explainable on the basis of the dispatcher's sheet, special technical aides conduct investigations and experiments to find and eliminate causes. It might also be mentioned that in case of fire the dispatcher's phone becomes the channel for the issuance of orders relative to the disposition of forces, and for the receipt of reports on progress in control.

The maintenance of facilities is no inconsiderable part of the pipeliners' responsibilities. Lines have to be protected against corrosion, and in many places require periodical treatment. Innumerable pumps of all types and sizes have to be kept in good working condition. Tanks have to be cleaned when they are changed from heavy to light oil storage. They also have to be painted for protection against corrosion, and to minimize evaporation of the contents. Dehydrating plants, where they are a part of pipe line equipment, pump stations and tank farms with all their accoutrements, need some degree of upkeep and some measure of adaptation from time to time. New properties have to be tied into existing lines as they become productive; old ones have to become salvaged as the fields they serve become exhausted. Additional lines have to be laid to take care of discovery fields, and increased storage installed to provide for new production. All exchanges of information with respect to these matters are to be found in the dispatcher's "dope" book, and receiving and entering them certainly keeps the time from hanging heavily on his hands.

Despite the diversity of operations and activities already mentioned, they are not all the interests of the dispatcher. Into his dope book go work reports from the various pipe line gangs, carrying on a multiplicity of jobs that are highly essential to the departmental function. He is the Czar of the company phone, and a call to him has a high priority. To him come first accounts of pipe line leaks, fires, accidents, new wells—anything, in fact, that is oil news out in his district. Such reports he passes along to the interested person or persons. For many years he has been one of the busiest and at the same time most obscure individuals in the oil industry. He is likely to remain a busy individual, but in recent times there has been a growing tendency to gather the pipeliners together for the discussion of mutual problems, and through these meetings, the dispatcher is gradually becoming to his associates something a little more tangible than a voice. ★★★

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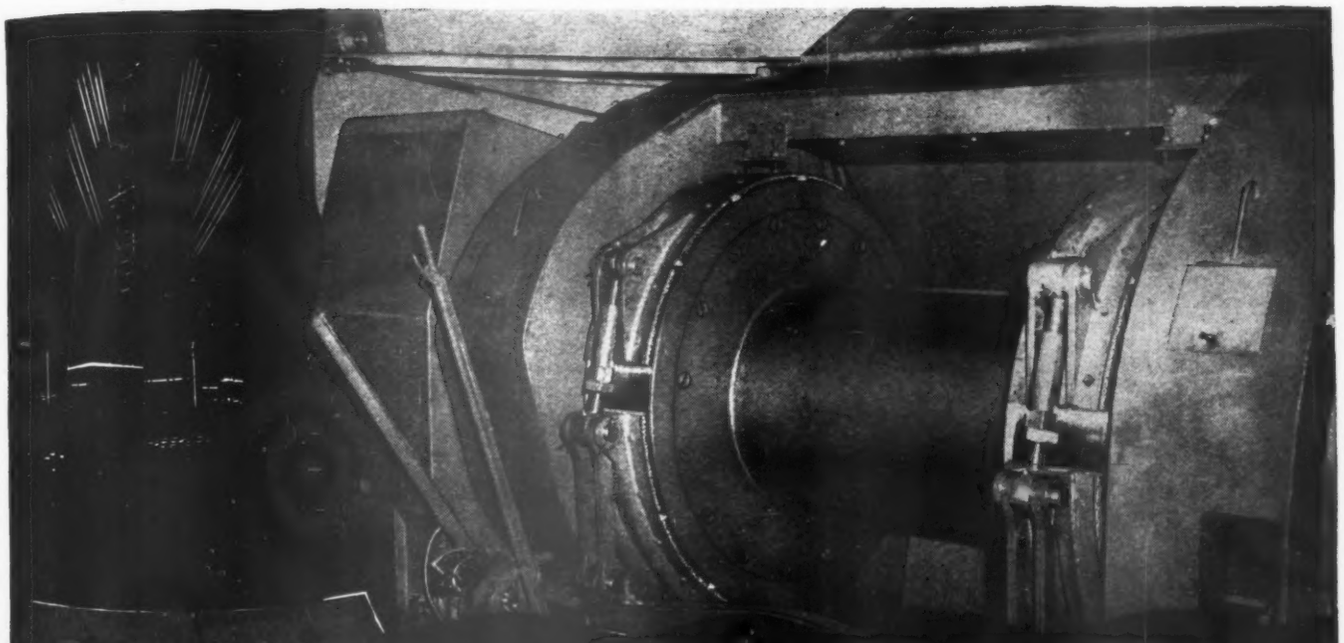

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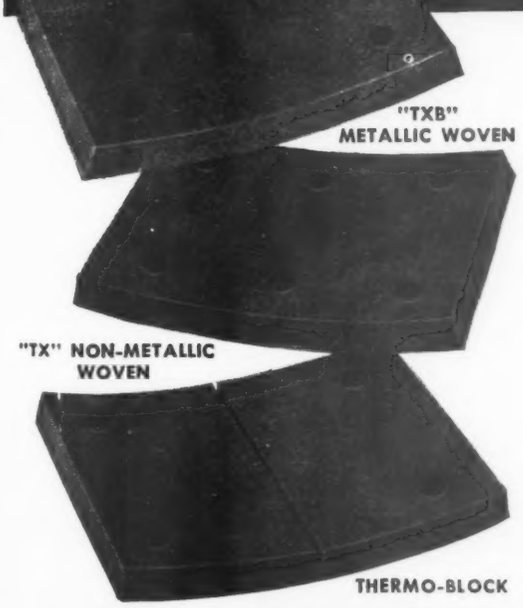

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Thermoid OIL FIELD PRODUCTS

The function and use of petroleum engineering committees*

By **D. V. CARTER**, *Chief Petroleum Engineer*, Magnolia Petroleum Company

PART 3—Conclusion

Appendix

October 27, 1944.

From Walace Hawkins
To D. V. Carter
Subject: *Mississippi Oil and Gas Engineering Committee*[30]

Dear Sir:

We have considered the Mississippi oil and gas engineering committee's proposed organization and activities. You inquire whether the antitrust laws prohibit such organization and activities. We answer that they do not. This conclusion is based on the following statements:

The joint and cooperative activities proposed include a loose-knit, unincorporated, voluntary, fee membership, statistical committee. There will be some salaried agents. The activities pertain solely to professional and technical men and are confined to a statistical program. The committee will secure and determine engineering data relating to oil, condensate, gas and water production, reservoir pressures, oil and gas ratios, initial production, surface pressures, open and closed, periodic and cumulative production, and other similar factual data determined by the committee. Activities embrace the assembling and tabulating of such data periodically covering different leases and fields in Mississippi. The distribution and dissemination of such data are to members only and to the Mississippi Oil and Gas Board, a state statutory regulatory body concerned with such facts. Membership is not closed or restricted, but is extended to all eligible members. Dissemination of information by the committee is unaccompanied by comments, interpretations or suggestions. There is no agreement or understanding, expressed or implied, with respect to prospecting and production policy to be pursued, nor is there restriction on competition in oil and gas producing operations.

Although there may be doubt that the federal antitrust law applies (see Railroad Commission of Texas v. Rowan and Nichols, 310 U. S. 570; Burford v. Sun Oil Company, 319 U. S. 315; Parker v. Brown, 317 U. S. 341; Connally Hot Oil Act; Federal Natural Gas Act), it is assumed that it may. Only a few adjudicated federal cases outline the permissible pattern for joint and cooperative statistical activities and programs.

I see no illegality merely because the accumulated data are restricted to members and the state regulatory agency. It is confidential and is the result of professional attainments. There is no prohibited restraint, reasonable or unreasonable, in the joint and several holding of private property resulting from professional data. There are no joint comments, interpretations or suggestions with respect to future production policies. Past and current transactions as to producing operations only are embraced in the statistical program. Moreover, producing policies are subject to state regulation. While no statistical program has been condemned merely because transmission of data is accompanied by comments, advice and suggestions as to future action, I note you prohibit the committee or its members from making suggestions, comments and interpretations as to future producing policies. This avoids the appearance of evil that such interpretations, suggestions or comments in reality form an agreement as to producing policies. Oral discussions by the committee are contemplated at meetings. These discussions do not embrace future producing policies of members. Adequate and sufficient defense is available should such prohibited discussions creep into the committee meetings of these technical and professional men. The safety lies in the fact that such technical and professional men have no power and do not in fact determine, control or fix the producing policies of the operators. There are no committee recommendations as to production policies. There is no policing of any plan of production. There is no enforcement machinery to compel obedience to committee interpretations, suggestions or comments which relate to producing programs.

We have heretofore examined similar engineering committee organizations and activities for the same purpose, such as the Goldsmith Pool Engineering Committee, North Basin Pool Engineering Committee, East Texas Association, Yates Pool Operators, Lea County Engineering Committee, Conroe Engineering Committee, Fullerton Engineering Committee, West Edmond Engineering Committee, and many similar committees limited to unitized operations.

A statistical program of this type has not been picked out as a device of monopolies in the pending antitrust case (United States of America v. American Petroleum Institute). Mr. Cook, in his monograph on "The Control of the Oil Industry by Major Oil Companies," based on testimony before the Temporary National Economic Committee, does not single out engineering committees as a method or device employed in the control of discovery, and production of oil and gas (Monograph 29, Government Printing Office, 1941). Mr. Pearce, who wrote Monograph 18, "Trade Association Survey," likewise based on the evidence taken by the Temporary National Economic Committee, shows the extent of such permissible statistical programs in the United States (Government Printing Office, 1941). Mr. Handler, who wrote Monograph 38 on "Study of the Construction and Enforcement of the Federal Antitrust Laws," based upon the same committee's hearings and testimony, sets out what he thinks is the test of a permissible statistical program (Government Printing Office, 1941). Your proposed organization activities meet his test.

Assuming that immunity from the federal antitrust law was available under Title 50, U. S. C. A., Section 12. under Recommendation 13, Petroleum Coordinator for National Defense, acting under Executive Order 9276, December 2, 1942, or other Petroleum Administration for War directives, it should not be sought for the cooperative and joint activities which you contemplate. The Mississippi statute giving immunity is probably broad enough to cover this. It should not be sought because there is no ground for illegality.

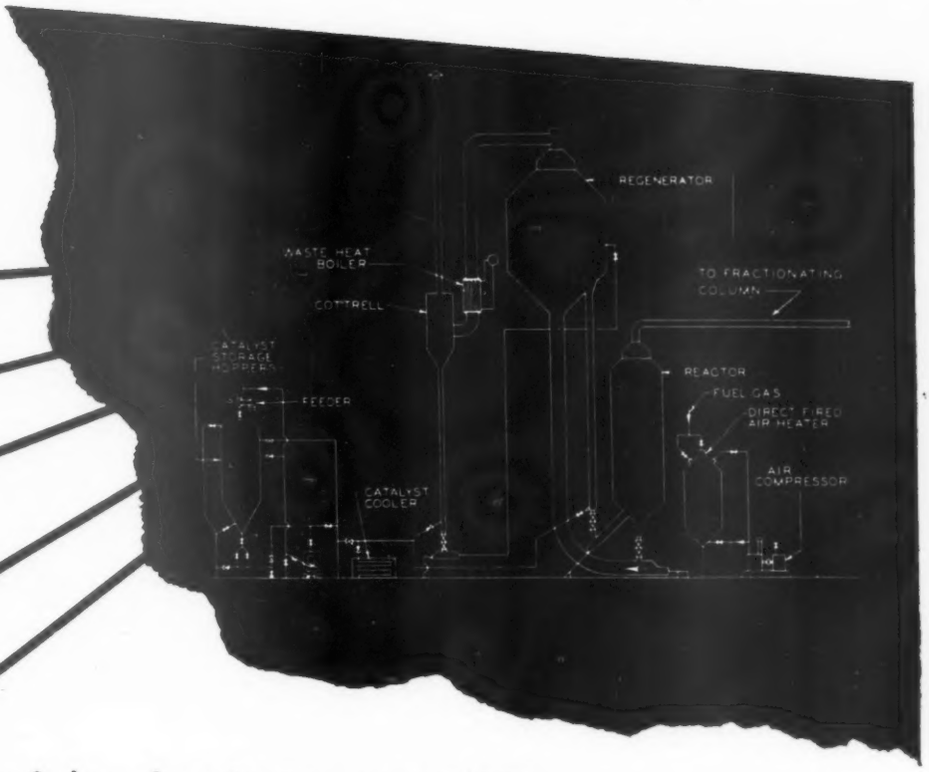
I should mention an irrelevant matter. The committee data should not be subject to court subpoena at the instance of third parties, public or private, nor even by members for the purposes of private litigation or for other purposes, running to and served upon committee personnel as such. The data you accumulate are and should be the private property of the members as operators. Committee members subpoenaed to testify should claim immunity based upon the ground that professional testimony is sought to be elicited and on the further ground that the necessary data from which to testify professionally are not the property of the witness but must be obtained from the individual members.

Respectfully,
(Signed) Walace Hawkins.

*Delivered before a joint meeting of the Illinois Society of Petroleum Engineers and the Illinois Basin Chapter of the American Petroleum Institute, Mt. Vernon, Illinois, March 1, 1946. Parts 1 and 2 were published in *The Petroleum Engineer*, issues of July and August, 1946.

30. "Cooperative Activities of Engineering Committees and Associations." Raymond M. Myers, Legal Department, Magnolia Petroleum Company, Dallas, Texas (1944). Unpublished memorandum.

at Avon !



Designers of the electric power system in this new Tide Water cracking plant made *continuity of service* their chief objective— and G-E equipment helped them achieve it!

In the new cracking plant of the Tide Water Associated Oil Co. at Avon, Calif., the continuous nature of the fluid-catalytic process makes even occasional power interruptions intolerable. Failures have to be "squelched" before they start!

Avon's designers asked General Electric to provide power transmission equipment, motors, and controls which would stay on the job with a minimum of maintenance. Specifications were met to the letter *without* installing costly "custom made" equipment. We were able to supply standard equipment with all the construction "extras" required.

The result is a power system which points up G-E's ability to meet the exacting electrical requirements of all refinery processes, whether in general use or still in the pilot-plant stage. Here's a quick description of the Avon system:

POWER DISTRIBUTION — Power at 12,000 volts from a nearby utility is carried into the plant over two independent circuits. Should one circuit fail, the load is automatically transferred by high-capacity G-E oil circuit breakers. This arrangement also eliminates service interruptions for maintaining breakers. Six feeder circuits, all controlled and protected by G-E circuit breakers, distribute the power to utilization points. Full-rated performance of motors and lighting fixtures is assured by G-E load-center unit substations, designed for operation in semi-hazardous areas, close to the load. Both high- and low-voltage circuits are buried underground out of harm's way.

CONTROLS — Induction motors for driving tank mixers, precipitators, and other equipment are controlled by G-E Limit-amp combination starters. The current-limiting fuses are rated for short-circuit kva up to 150,000 at 2300 volts, 250,000 at 4160 volts. Low-voltage starters for the smaller motors, also of adequate interrupting capacity, are conveniently racked for fast inspection and easy servicing.

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G.E. makes the electrical industry's most complete line of equipment specially designed for refinery service. This fact is welcomed by many refinery engineers for the greater freedom it gives them in matching power distribution and utilization systems of continuous processes. Your nearest G-E office will be glad to discuss any electrical problem with you. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

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STATE OF MISSISSIPPI
Executive Department
Jackson
August 2, 1945

Mr. D. V. Carter
P. O. Box 900
Dallas, Texas
Mr. L. H. Moore
P. O. Box 1731
Shreveport, Louisiana
Mr. J. D. Davis
P. O. Box 1020
Jackson, Mississippi
Gentlemen:

The Oil and Gas Board is engaged in the preparation of a brief to be presented in connection with the forthcoming natural gas investigation of the Federal Power Commission.

Mississippi is scheduled to be heard on October 30, 1945. There is a great deal of information which is necessary for the preparation of this brief and while a considerable portion of this data is available in the files of the Oil and Gas Board, and the Mississippi Oil and Gas Engineering Committee, which you head, it will be necessary to go to the industry for more information and also to prepare charts, graphs and maps in connection with the testimony offered.

The purpose of this letter is to ask you to give Mr. Alec M. Crowell, Petroleum and Natural Gas Engineer of your committee, permission to assist Mr. H. M. Morse, our State Supervisor, and others, in the preparation of this report.

Mr. Crowell is experienced in the preparation of such reports and has given us every assistance since your office was established here.

It would be appreciated if such arrangement could be made.

Thanking you and with best wishes, I am

Very sincerely yours,
(Signed) Thos. L. Bailey,
GOVERNOR.

Dallas, Texas
August 6, 1945

Hon. Thomas L. Bailey
Governor of Mississippi
Jackson, Mississippi
My dear Governor:

The Mississippi Oil and Gas Engineering Committee has heretofore considered the scope of activity of its director, Mr. Alec Crowell, in respect to the appearance and presentation of a case before the Federal Power Commission in its natural gas investigation on behalf of the State of Mississippi and its industry.

This is a joint reply from all addressees to your letter of August 2, and is intended to make explicit the extent of Mr. Crowell's participation and cooperation with the State of Mississippi and its industry in the presentation of any case to the Federal Power Commission which it desires to make.

Mr. Crowell is and will be available to any of the officials of the State of Mississippi or to witnesses which it selects for the purpose of investigation, the collection and assembling of facts, and data desired. Under our by-laws, Mr. Crowell cannot appear as a witness in such hearing. He cannot express an opinon on the facts for and in behalf of the committee or any member of the organization. He cannot serve as a member of any committee preparing the case for the State of Mississippi before the Federal Power Commission. He will freely cooperate in the respects permitted above.

I should point out and I know you will appreciate and understand that it is the purpose of the committee and its objects are limited to the maintenance of its status as a pure fact-accumulation, fact-finding and distribution body. The facts and factual data of the committee are limited to members and to the supervisor of the Mississippi Oil and Gas Board. We are highly concerned that neither this committee as such nor its director became involved in opinions, controversial matters or political considerations. Its efficiency and justification depend on this.

Respectfully,
D. V. Carter, Chairman.

DVC:eb
cc: Mr. Greek L. Rice, Attorney General, State of Mississippi
Mr. Guy McCullen, Land Commissioner, State of Mississippi
Mr. H. M. Morse, Supervisor, Mississippi Oil & Gas Board
Mr. Alec M. Crowell, Director, Mississippi Oil & Gas Engineering Committee
Mr. L. H. Moore, Vice Chairman, Mississippi Oil & Gas Engineering Committee
Mr. J. D. Davis, Chrm. Ex. Com., Mississippi Oil & Gas Engineering Committee
Mr. M. E. Norman, Secretary-Treasurer, Mississippi Oil & Gas Engineering Committee
Mr. Paul F. Barnhart, Ex. Com., Mississippi Oil & Gas Engineering Committee.
Mr. J. S. Boldrick, Ex. Com., Mississippi Oil & Gas Engineering Committee
Mr. J. J. Bresenham, Ex. Com., Mississippi Oil & Gas Engineering Committee
Mr. J. W. Gill, Ex. Com., Mississippi Oil & Gas Engineering Committee
Mr. A. S. Rhea, Ex. Com., Mississippi Oil & Gas Engineering Committee
Mr. M. A. Wright, Ex. Com., Mississippi Oil & Gas Engineering Committee.

Articles of Organization of Mississippi Oil and Gas Engineering Committee

Section 1.
Name

The name of this committee is the Mississippi Oil and Gas Engineering Committee.

Section 2.
Purpose

The purpose of this organization is to collect, arrange in an orderly manner, and distribute factual reservoir engineering data, as herein defined, of the various oil and gas fields in the State of Mississippi.

Section 3.
Organization

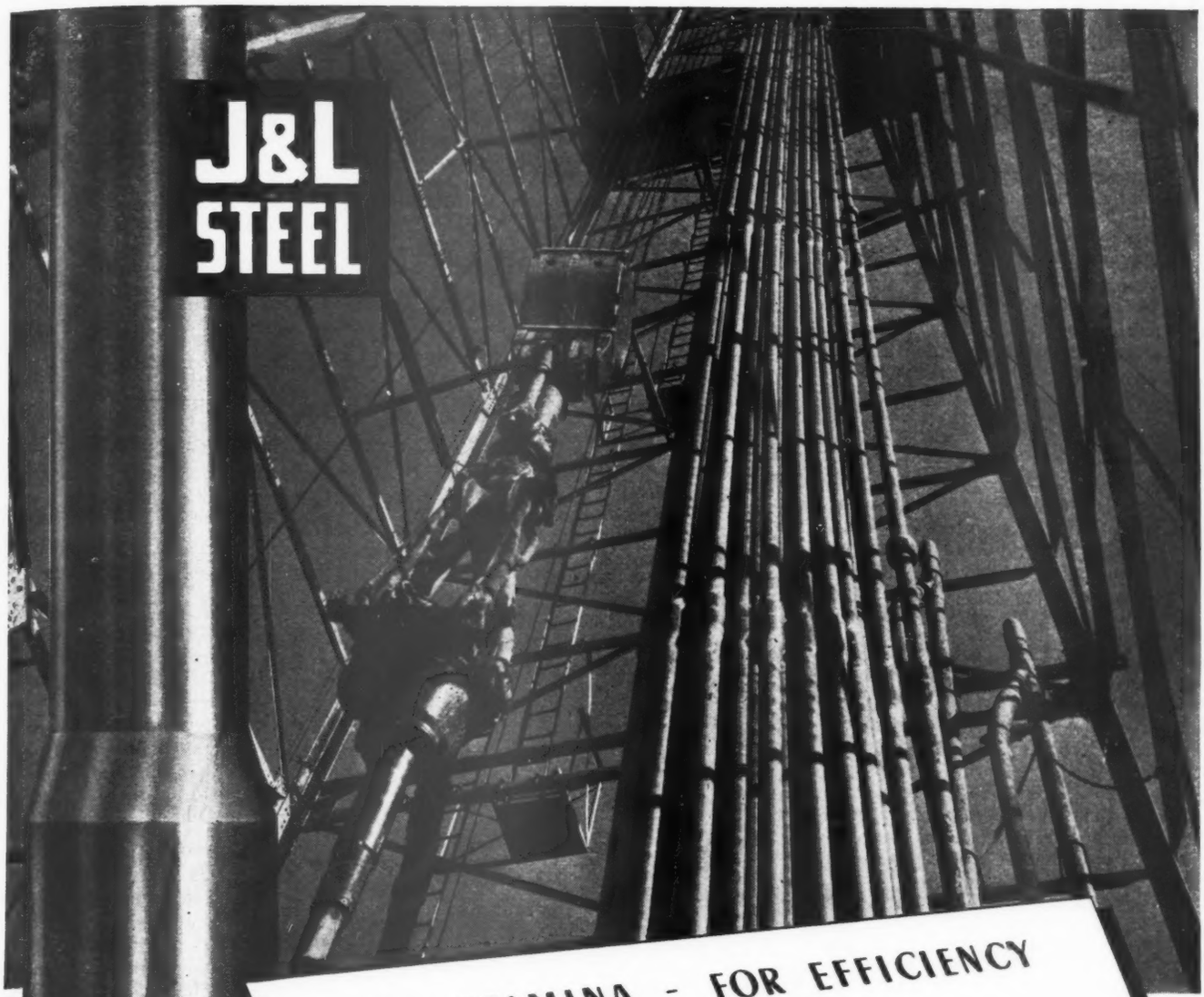
The organization of the Mississippi Oil and Gas Engineering Committee shall consist of the following:

(a) *The General Engineering Committee.* The General Engineering Committee shall be composed of one representative from each company or individual engaged or interested in the production of oil and gas in the State of Mississippi and who has signed these articles of organization. Each representative must be either engaged in the petroleum industry in a supervisory capacity or be a technically trained man in production and, if possible, he a resident of the State of Mississippi, provided however the supervisor of the Mississippi State Oil and Gas Board is an ex-officio member of the general committee. The representative may be changed from time to time by his principal who shall notify in writing the Chairman of the General Engineering Committee of such change. Each participating company or individual shall have one vote in the General Engineering Committee and a majority of those present shall carry a motion. Each representative on the General Engineering Committee may, at his option, be represented by an alternate. The General Engineering Committee shall at its meeting of organization, and annually thereafter, elect a General Committee Chairman, a General Committee Vice-Chairman, and a secretary-treasurer from its own membership, who shall hold

Association plans global co-operative agency

Zurich, Switzerland, will be the scene on October 1 for a meeting of the large consumers of petroleum products in 40 countries to plan the organization of a global free trading agency to be known as the International Co-operative Petroleum Association.

This new organization is a projection of the Consumers Co-operative Association, formed 25 years ago in Kansas City by a group of farmers. Similar co-operative oil groups have sprung up in Sweden, Britain, Norway and other countries throughout the world, and it is representatives of these organizations who will meet in Zurich to map a new international petroleum co-operative. If the articles and bylaws of the proposed league are accepted, the organization will proceed with a program of world trade expansion that envisages the acquisition of new oil fields in Saudi Arabia and Latin America, and later, operation of a transatlantic shipping company.



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office until their successors have been elected. The chairman or vice-chairman in his absence shall preside at all meetings of the General Committee. Any member of this association may withdraw herefrom and withdraw his or its representation on the General Engineering Committee by giving thirty (30) days written notice to the chairman and upon paying all of such member's assessments and dues then accrued.

(b) *Executive Committee.* An Executive Committee shall be created, consisting of seven members of the General Committee, to be elected at the annual meeting by the General Committee, and who preferably shall be residents of the State of Mississippi. At least five members of the Committee shall be representatives of oil or gas producers in the State of Mississippi. The Executive Committee shall assist the director in carrying out the purposes set out in this agreement. The Executive Committee shall elect an Executive Committee Chairman and Secretary from its own membership following the election of such committees by the General Committee.

(c) A Director shall be elected by the General Committee and shall devote his full time to the work of the Committee and shall be compensated at a salary fixed by the General Committee. He shall direct the work of the various committees and in general shall carry out the purposes of this organization under the general supervision and control of the General Committee through the Executive Committee.

The Director may appoint such field committees, with the approval of the Executive Committee, as are necessary to carry out the purposes of the Committee. All operators in a specific field and who are members of the Mississippi Oil and Gas Engineering Committee may have a representative on such field committees.

The Director shall be supplied with adequate office facilities, equipment and personnel to meet field and office requirements, selection of such personnel and equipment to be made with the approval of the Executive Committee.

(d) *Field Committees.* There shall be appointed such Field Committees as the Director, with the approval of the Executive Committee, finds necessary to appoint in order to carry out the purposes of the Committee.

Section 4.

Meetings

The annual meeting shall be held at Jackson, Mississippi, within two weeks of the anniversary of the date of organization of the Mississippi Oil and Gas Engineering Committee.

The General Chairman shall be required to call a meeting of the General Committee upon the petition of ten members thereof, written notice to be given at least ten days prior to the meeting. Meeting of the Executive Committee shall be called by the Executive Committee Chairman upon the petition of four members thereof.

Field committees, provided for herein, shall meet at the call of the Director of their respective field chairman.

All committee meetings shall be held in the State of Mississippi.

Section 5.

Expenditures

The Director is authorized to make expenditures that are usual and ordinary in the work of the committees, but shall make no expenditures in excess of the sum of $500.00 without the approval of the Executive Committee. The expense account of the Director shall be subject to approval by the Executive Committee Chairman before being paid by the General Secretary-Treasurer.

All expense of the work of the committees shall be paid by the members of the General Committee on the following basis:

(a) Each member of the General Committee shall, upon signing these articles of organization, be assessed and shall pay $100.00 to the General Secretary-Treasurer as his annual membership dues and shall thereafter be assessed and shall pay to the General Secretary-Treasurer $100.00 within two weeks of each anniversary of the date of organization so long as he remains a member of the General Committee.

(b) Any additional expense incurred by the General Committee in addition to the amount collected in (c) above shall be apportioned and assessed among the members of the General Committee in the proportion that each member's production of oil and condensate in the State of Mississippi for such month bears to the total production of oil and condensate of all members in said State for such month. The inclusion of gas production in the expense of this organization is to be made on an equalized value basis to be formulated by the Executive Committee when gas production is secured from new pools.

A statement shall be rendered monthly to each member showing what shall be due and payable, and such statement shall be paid within twenty (20) days after receipt thereof. The right of membership shall cease upon the failure or refusal of any member to pay assessments when due.

Section 6.

Use of data

The factual data reports as defined herein shall be distributed to and shall be limited to the use of the members, provided, however, that copies of all such reports may be furnished to the State Oil and Gas Board of Mississippi. It is specifically provided that such reports shall not be released for publication by any of the recipients thereof.

No member of the committees, nor the Director, is authorized to speak for the committees without the unanimous consent of the General Committee. This is not intended to place any restrictions, however, upon the right of any member or the Director to express his personal opinion or the opinion of the company that he represents.

Membership and participation directly or indirectly in this committee shall not be construed as restricting or controlling the prospecting, operating, and production policy and practice of any member.

Section 7.

Amendments

This agreement may be amended by the vote of two-thirds of the members of the General Committee.

Section 8.

Factual data defined

The factual data by pools shall comprise:

(1) Developed area.
(2) Name of producing formation.
(3) Number of wells.
(4) Average porosity.
(5) Permeability range.
(6) Average depth.
(7) Original gas-oil contact.
(8) Original oil-water contact.
(9) Gravity of oil.
(10) Gravity of gas.
(11) Bottom-hole temperature.
(12) Average gas-oil ratio.
(13) Average bottom-hole pressures.
(14) Current and cumulative production history of (a) oil, (b) water, (c) gas.
(15) All gas-oil ratio and pressure tests made under the direction of the director.
(16) Any factual data submitted by members of the General Committee and approved by the Executive Committee.

Section 9.

Policy

All employees of the Committee shall be prohibited from purchasing and dealing in oil and gas royalties, leases, and properties in the State of Mississippi.

WITNESS our hands on this..... day of .....194....

General references.

"Oil Field Operation With Cooperative Engineering Committees." V. E. Cottingham. *Interstate Oil Compact Quarterly Bulletin.* 2 (4) 15, December (1943).

"Value of Cooperative Engineering Field Committees." C. C. Rae. *The Oil Weekly.* 103 (1) 39, September 8 (1941).

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"Cooperative Reservoir Control in the K-M-A Field." William H. Rouzer, Jr. *Interstate Oil Compact Quarterly Bulletin.* 2 (4) 26, December (1943).

"Oil and Gas Development in New Mexico." A. Andreas. *The University of New Mexico Bulletin* Whole Number 343, Geological Series. 5 (3) 7. May 1 (1939).

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The History of the Standard Oil Company. Ida M. Tarbell. The MacMillan Company. New York (1933).

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"Effect of Dissolved Gases Upon the Viscosity and Surface Tension of Crude Oil." C. E. Beecher and I. P. Parkhurst. *AIME Petroleum Development and Technology in 1926,* 51, (1927).

Editor's note: **The article following, "Operation and Cost of an Engineering Cooperative" by Alec M. Crowell, is a part of this paper as it was presented.**

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Operation and cost of an engineering cooperative*

By **ALEC M. CROWELL,** *Director,*
Mississippi Oil & Gas Engineering Committee

● **Abstract.** A group of cooperative and progressive oil and gas operators in Mississippi have proved that the most common complaint of the older oil and gas producing states—"lack of requisite data prevented the evaluation of petroleum reservoir behavior"—can be averted simply and inexpensively.

At an average cost of $4.75 per well per month an engineering cooperative representing 75 per cent of the wells and 68 per cent of the production of oil and gas in Mississippi has brought an understanding, not only between operators but also between state and operator, that is unique in the history of the petroleum industry.

Continuous pool studies reflecting the complete physical aspects of each oil and gas reservoir of Mississippi make possible an evaluation of economic conditions that is always current. Cooperative service has lightened the burden of the technical staffs of its operator-members with resulting economies.

Unlike the first cooperative formed some 20 years ago the work of the Mississippi Committee is confined to a geological, statistical, and factual-engineering program. No agreement or understanding, expressed or implied, with respect to the exploratory and development policy to be pursued, exists between members, and no restrictions are placed on competition in oil and gas operations.

This statewide petroleum engineering committee has proved advantages over the individual field engineering committee wherein membership is confined to actual operating interests. Conservation of oil and gas, rapid acceptance and assimilation of good operating practice and systems is being brought about at a cost of only 1/5 cent per bbl. of oil and condensate produced. And this cost is deductible from State and Federal income tax.

*Delivered before a joint meeting of the Illinois Society of Petroleum Engineers and the Illinois Basin Chapter of the American Petroleum Institute, Mt. Vernon, Illinois, March 1, 1946.

MR. D. V. CARTER, in his paper: "The Function and Use of Petroleum Engineering Committees," comprehensively covered the history, organization, scope of activities, and legal aspects of engineering cooperatives. He left me to answer, however, that first and Sixty-four Dollar Question inevitably asked by the brass—How much does it cost and why?

Although I would like to give you the answer to the last half of the question first, it won't be asked that way. So, the normal cost to operator-members for operation of the Mississippi Oil and Gas Engineering Committee is approximately 2 mills per bbl. of oil and condensate produced. The average cost per well is $4.75 per month or 15 cents per well per day—and that is a deductible item.

Seventy-five per cent of the oil and gas wells and 68 per cent of the production of oil and condensate in Mississippi are represented by members in the cooperative.

The Mississippi Committee has been in operation only 13 months; however, expenses for the first 12 months of operation are normal for such groups. A tabulation setting out the distribution of expense for the first year follows:

Expense distribution for first year.

Disbursement items	Per cent of total
Salaries	30
*Bank loan to meet initial expense	10
Automobiles	9
Publishing monthly and quarterly reports	8
Scientific equipment—field	7
Office equipment	6
Field travel expense	5
Auto repair and expense	3
Administrative expense—office	3
Rent and utilities	3
Professional services—extra help	3
Electric logs and drafting supplies	2
Telephone and telegraph	2
Postage and mailing service	1
†Miscellaneous service and supplies	8

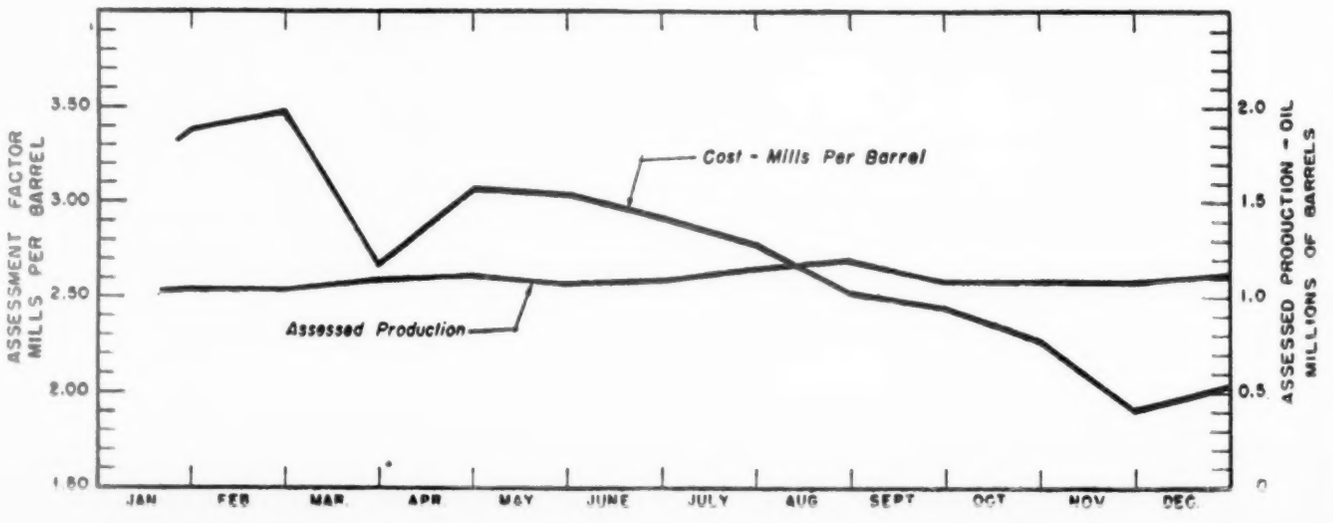
*Absorbed by monthly payments.
†Dues and subscriptions, printing and stationery, repairs to scientific equipment, interest on loan, maps, insurance, janitor service, federal old age benefit tax, licenses and taxes, repairs to office equipment, etc.

You will observe a very interesting fact from the chart, Fig. 1, that accompanies this paper. On this chart is depicted the production of oil and condensate assessed and the assessment factor for each month. The assessed production of the member operators increased approximately 10 per cent over the calendar year 1945 while the operating cost was reduced by more than half—from 4.92 mills per bbl. in February to 2.01 mills in December.

At the initial meeting of the Policy Group of the Committee I was told that the first and only objective of the cooperative was to gather factual field data covering such a range that recovery efficiency in the petroleum reservoir of Mississippi might be evaluated. The work was to be confined to physical aspects in the belief that an understanding of the physical behavior of the oil and gas reservoirs of Mississippi was of first importance and prerequisite to evaluation of economic conditions.

This was a large order, and now that the assignment has been successfully carried out I can confess that at first I felt that it was impractical. This belief

FIG. 1.



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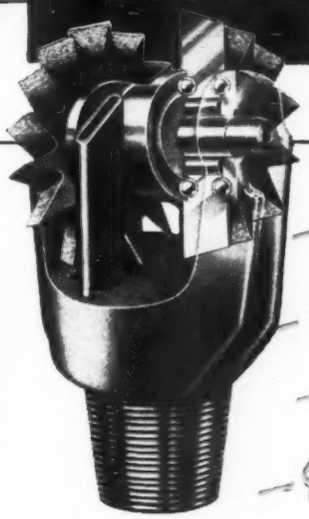

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for the reason that it was during time of war and the technical staffs of the various companies were busy; the data needed were considered by some companies to be private information; work of this nature in the past had been done by individual field committees wherein membership was confined to actual operating interest; and I could not see that the conservation of oil and gas would be furthered by the committee plan. I was wrong on all counts.

From the beginning it became apparent to the member-operators that by utilizing the services offered by the committee the burden on their technical staffs could be lightened with resulting economies. The information placed in the reports, although information still regarded as private by some, is requisite data for dependable analyses of field behavior and has lead to a better understanding not only between operators but also between the State of Mississippi and the oil and gas operator. Further, Mississippi is moving rapidly forward into the realm of good conservation practices and each step has been made through the facilities of the engineering committee.

The broad program outlined by the policy group contemplated information that can be divided into five general groups:

1. Reasonably accurate data on gas, oil, condensate, and water production for each reservoir and each lease within each reservoir.
2. Sub-surface pressure surveys for correlation with production data.
3. Productivity indices on a reasonable number of wells in each reservoir.
4. Analyses of sub-surface samples of reservoir fluids of each reservoir.
5. Geological aspects and structural data on each reservoir.

The information is essential to reservoir studies and has been gathered. The reports of the committee make the data continuous and current and the cost of gathering the information is insignificant in comparison with the benefits stemming therefrom.

The committee's most recent engineering-geological and statistical report, now being distributed to members as Factual Data No. 10, contains for each oil and gas reservoir in the State of Mississippi the data outlined above. For instance, on page 49 of this report there is a development map on the Pickens field of Madison and Yazoo counties, and on page 50 there is a contour map on the Wilburn sand reservoir of this field and also a cross-section on the same productive horizon.

On page 51, the page carrying the reservoir behavior chart here reproduced as Fig. 2, there are certain basic reservoir data. These data include field location, type of structure, name of the producing formation, ownership and discovery date of the discovery well, and current spacing pattern for the field. There are also set out the average elevation of the wells in the field, original water level, current water level, top of effective porosity, total effective section, bottom hole temperature, average porosity, and permeability. Further, the values are given for connate water, formation volume factor, an estimated recovery factor, gravity of oil and gas, gal. per M. of gas, original and current operating gas-oil ratio, and the original and current reservoir pressure at a fixed datum plane.

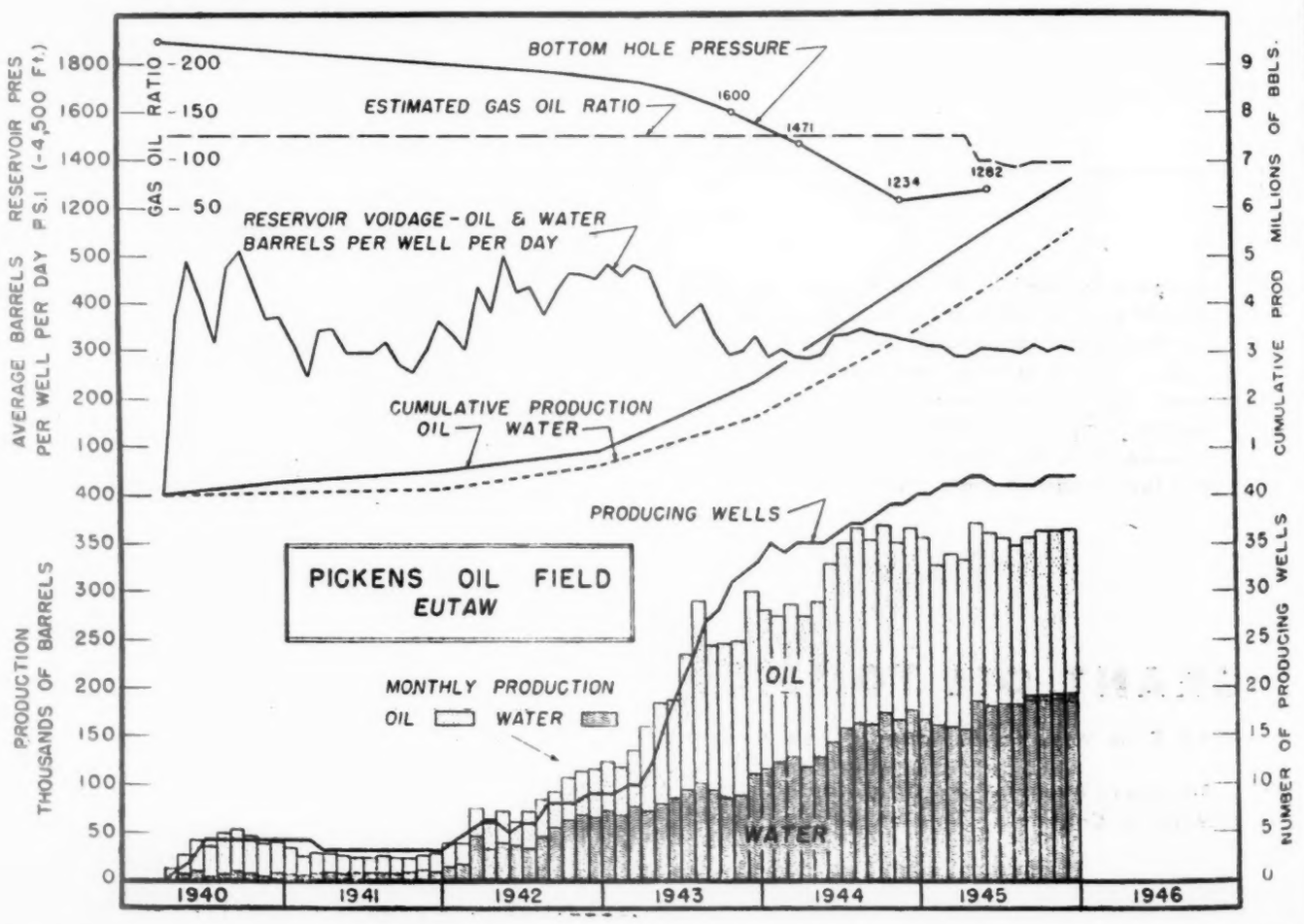
Beneath the basic reservoir data section of Fig. 2 is the reservoir performance chart and below that are the pool behavior statistics.

Each issue of the report sets out under the heading "Pool Behavior Statistics" for the current 12 months' period (by months) the number of producing wells, assigned acreage, reservoir pressure (interpolated to the last day of each month), the monthly production of oil, water, and gas, and the cumulative production of oil, water, and gas.

The mechanics of gathering this information have been pretty well worked during the past year. The development maps and reservoir performance charts are drawn by the committee's draftsman and the information placed on the maps and charts comes from the State Conservation Department, operator members and field tests made by the committee's own engineering staff.

Individual ledgers for each field on

FIG. 2



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the production of oil, condensate, gas, and water are kept in the offices of the committee for the use of its members. These production ledgers are subdivided, a section being devoted to the individual well and the individual lease in each reservoir. At the end of each month, from the data contained in these ledgers, is calculated the reservoir voidage represented by the production of oil, gas and water from each reservoir. Results of this calculation, expressed as reservoir voidage in barrels per well per day, are posted on a reservoir performance chart.

You will observe on the reservoir performance chart for the Pickens oil field this reservoir voidage curve. (Fig. 2). The relationship of the bottom hole pressure and voidage curve is the controlling factor in an evaluation of the current performance of the Pickens oil field.

Of all the data collected by the Mississippi Committee the most difficult has been the collection of reasonably accurate information on the production of water. This for the reason that water, unlike oil and gas, has no intrinsic value. There is no incentive to measure oil field water except in particular cases.

Over the past year the engineers of the committee have worked with the switchers and pumpers in the field, particularly those employed by the small operator. The engineers have shown these field men the use to which the information is put.

Cooperation between the field employes of most oil and gas operators and the committee engineers is excellent. A record of oil, condensate, gas and water production—beginning with its inception—on every oil and gas well in the State of Mississippi is now the property of the committee.

The facilities of the Mississippi cooperative are now complete. Equipment needed for the gauging of reservoir pressures, the measurement of natural gas and water, and a field laboratory for the calibration of these instruments are in operation. The office equipment includes, among other things, a drafting room, calculator, adding machine, and a bookkeeping and accounting system set up by a certified public accountant.

The personnel of the committee is seasoned and experienced. The senior petroleum engineer has a background of ten years and the junior petroleum engineer two years' field engineering experience. The draftsman works part time, being regularly employed by one of the larger oil companies.

The secretarial staff was selected after a careful search. No training was necessary as the staff is thoroughly familiar with geological and petroleum engineering work. This fact enabled the committee to get under way rapidly.

The production of oil and gas in Mississippi at this time is not of great magnitude when compared with production in your state (Illinois). The development of the oil and gas producing industry within the state may be said to be in its infancy, but the discoveries to date and the magnitude of current exploratory effort clearly indicate that the production of oil and gas in Mississippi is destined to be of major importance not only to Mississippi but also to the country as a whole.

Although oil was discovered in Mississippi only six years ago a wide range of oil sand conditions is represented by the 23 reservoirs now under study. There are many variations in recovery mechanisms, extending from fields produced by wide open flow to fields operating under voluntary restricted rates of withdrawal. Oil and condensate gravity among the fields range from 14 to 68 deg. API. The well spacing patterns are fixed at 40 acres for oil wells and 320 acres for gas or condensate wells under the state's state-wide spacing rule. There are few exceptions to this spacing rule.

The common complaint of older oil and gas producing states that lack of requisite data prevented the evaluation of reservoir behavior cannot happen to Mississippi so long as the engineering cooperative functions. Through the facilities of the committee, pool studies are continuous and provide an unusual amount of field data on the oil and gas recovery process. The first year of operation has seen a substantial advance toward fulfillment of the fundamental objective of the policy committee.

★ ★ ★

Editor's Note: This is the conclusion of a paper by D. V. Carter, of Magnolia Petroleum Company, and Alec M. Crowell of Jackson Mississippi, on petroleum engineering committees.

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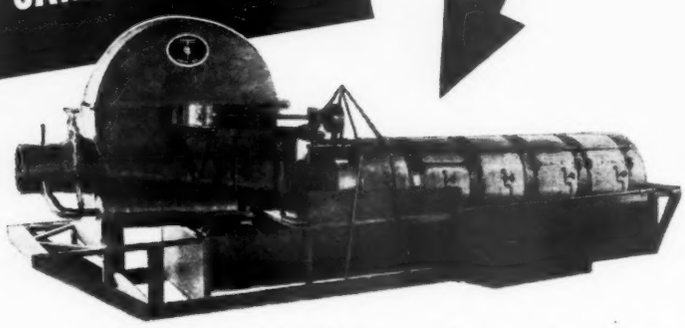

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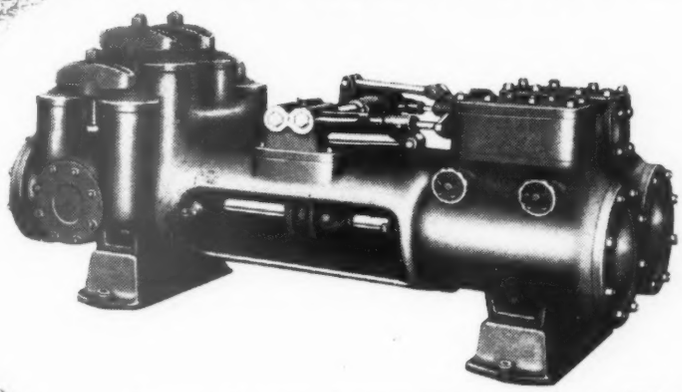

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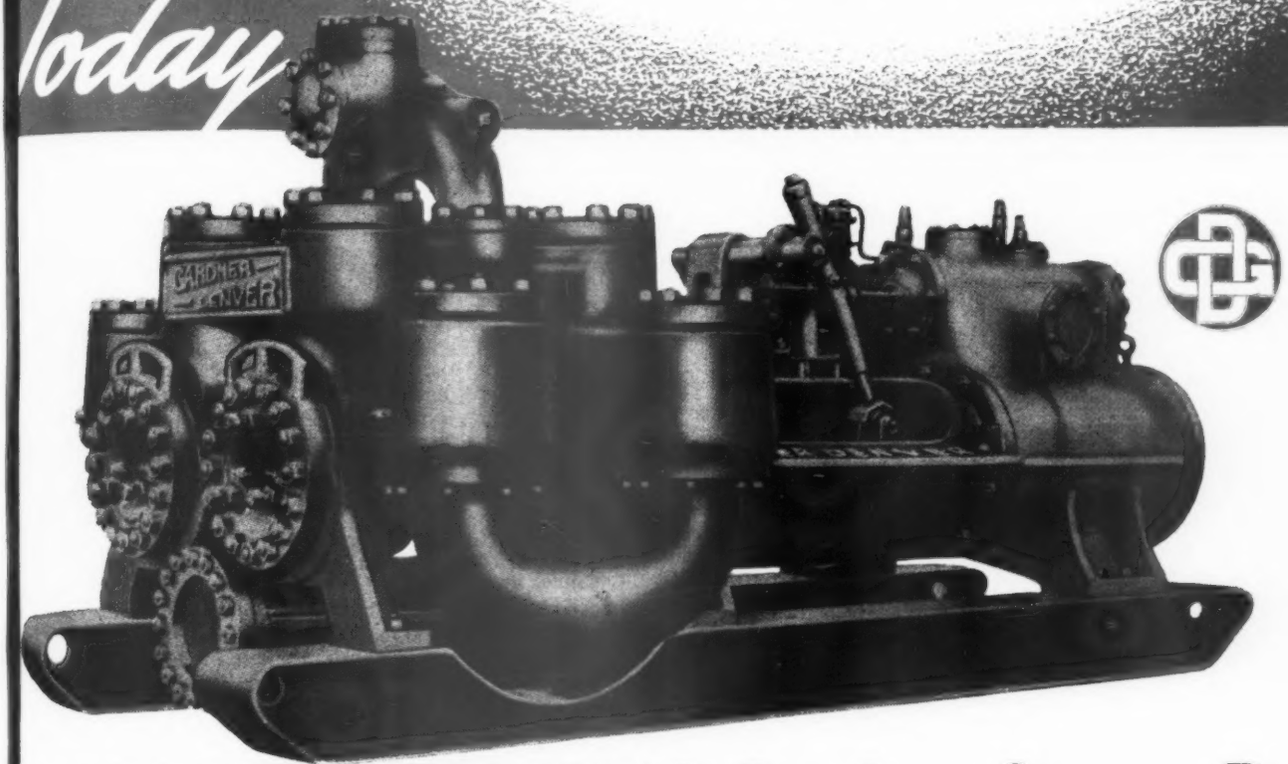

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The investment value of injection gas*

By **M. L. ARNOLD**, Richfield Oil Corporation

THE old adage "Bury your money deep in the ground and you'll get no interest when the first rolls around" doesn't apply if your money is represented by gas owned or purchased and the burial is effected by injecting the gas into an oil producing reservoir. This opinion, that substantial increases in both the recovery of oil and net profits can be obtained by the use of injection gas in primary pressure control and secondary recovery operation, seems to be so generally accepted among petroleum engineers that it is difficult for one who has spent most of his life on the gasoline plant side of the fence to understand why gas injection is not more generally practiced.

In certain instances, conditions within the reservoir itself may make gas injection uneconomical. In other instances, inability to obtain the cooperation of all or a sufficient majority of the operators may preclude such a program.

Perhaps, we in the natural gas and gasoline industry are at fault. Perhaps, we have not given gas injection programs our enthusiastic support because it means foregoing for a comparatively long period of time the revenue enjoyed from the sale of residue dry gas.

Although this paper contains data that is believed to be of general interest, it is directed particularly to the men in the natural gas and gasoline divisions of the petroleum industry in the hope that it may arouse their more active interest in gas injection projects. For this reason, the discussion will be developed as follows: First, a brief statement of the necessity for and the objectives of gas injection; second, a discussion of the results of an economic analysis of a hypothetical project, by methods that are applicable to any type of injection project; third, a discussion of methods for making greater quantities of gas available for injection. Some of these methods, if found to be economically feasible and placed in operation, would greatly enhance the prestige of the natural gasoline divisions within the oil industry.

For a statement of the necessity, objectives, and results to be expected of gas injection, I am going to quote directly from an article[1] co-authored by a man whose opinions are highly respected both by natural gasoline men and by production men. He is E. O. Bennett, formerly chief petroleum engineer of the Continental Oil Company, now a private consultant, and a recognized authority on this subject. The quotation follows:

● **"Pressure maintenance.** Oil can be produced only when some form of energy causes it to be moved into a well bore by a differential pressure between the producing zone and the bore. The well may be considered as a vertical pipe line to conduct oil from the point at which it enters the bore to the surface.

"Without energy in some form to move oil into well, the largest deposit would be valueless. Energy for lifting purposes is readily available, but it is extremely difficult to place it in the formation at remote distances from wells. The principal forms of energy associated with oil are gas and water. The gas may be in solution in the oil under formation pressures or in a gas cap immediately over the oil, or both. The water is either directly under the oil or at the edge of the structure flank. Water has no energy within itself to move oil unless it is under a hydrostatic head.

"A cubic foot of gas under pressure contains energy; this energy, properly utilized, can do useful work. The amount of energy in a cubic foot of gas in a producing formation is determined by the pressure at which it is compressed. This applies to both free gas and gas in solution. The useful work done by the energy in the gas is controlled by the manner in which it is used.

● **"Repressuring.** It has been definitely proved that supposedly depleted pools have been made to produce large volumes of oil by the addition of energy in the form of gas under pressure, a process ordinarily designated as 'repressuring.' This process has made possible the obtaining of many additional millions of barrels of oil. Oil that is removed under a 'repressuring' program has generally lost a large percentage of gas that was in solution at the initial formation pressure. Oil that has gas taken out of solution has its viscosity materially increased, and more energy is required to move it through a given distance in any particular formation. For these reasons oil under a 'repressuring' program has generally for production than that produced under flush conditions.

● **"Pressure maintenance.** If the original reservoir-pressure conditions could be maintained at all times the greatest maximum ultimate recovery would be obtained because the oil would be less viscous, and the largest possible amount of energy would be available to create maximum differential of pressures between the formation and the well bore for moving oil through the formation. Initial conditions of pressure and energy cannot be maintained without the injection of all gas produced, plus enough additional gas to occupy the space originally containing the liquid volume of oil withdrawn.

"It is not always feasible or economical to return this extra volume required; but it is generally practical and economical to return the gas produced with the oil at the early life of the field, even though the pressure required is great. Early injection of gas into a producing pool is called 'pressure maintenance.'

"The gas volume and rate of pressure decline in a pool under pressure maintenance is kept more nearly in balance with the rate of oil production. At such time as the pressure slowly declines to a value that oil can no longer be produced, it is estimated that volumes up to 60 per cent or more of the total oil in the reservoir pore space will be recovered. This is much more than can be expected under production methods generally carried on in the petroleum industry."

The foregoing quotation is from an article published in 1937 describing Continental's installation for producing the Tepetate field under primary pressure control. The installation had undoubtedly been made because Mr. Bennett, and the Continental Oil Company, believed that he could predict the recoveries of oil that could be obtained from a reservoir by various production processes. Based upon such an estimate and the associated lifting costs, production under primary pressure control with injection gas must have looked profitable; but, we wonder, can anyone estimate reservoir performance sufficiently close to enable such decisions to be made?

To obtain the answer to this question, and to some others, suppose we carry on an imaginary conversation with Mr. Bennett. "Mr. Bennett", we say, "I have just looked over those statements you made in 1937, regarding Tepetate, and a statement from another article[2] indicating that recoveries from deep, high-pressure zones may be increased from 40 to 100 per cent by the installation of pressure maintenance operations. Now that you have had several years' experience at Tepetate, don't you concede that you were considerably off the beam when you made those remarks?"

We find Mr. Bennett's reply in another article[3], which he co-authored "Tepetate Six Years Later" published in 1943. It is as follows:

"The Tepetate field has been producing for over 7 years, and pressure-maintenance operations have been conducted for over 6 years of this time. The oil recovery to date is greater than the estimated ultimate recovery would have been had the field been produced in the conventional manner. The estimated recovery from this pool by ordinary means of production was 11,000,000 bbl. Production to date is nearly 12,000,000 bbl. All oil subsequently recovered to the economic depletion of the pool will be obtained on account of the continuous return of gas to the producing formation. The ultimate recovery, under the plan instituted, is expected to be as much as

*Presented at monthly meeting of California Natural Gasoline Association, Los Angeles, April 4, 1946

150 to 175 per cent of the ultimate that would have been produced by normal recovery methods."

"Well," we say. "That seems to be quite conclusive evidence that your estimates were good. I am sorry that I questioned your ability to make such forecasts, but how about lifting costs? That large compressor installation looks expensive. Think of the number of men required to operate and maintain it. Wouldn't it have been more economical to have forgotten the increased recovery and produced the normal amount by conventional production processes?"

Mr. Bennett replies from the same article:

"The saving of pumping equipment otherwise required and the reduced lifting cost for the oil produced up to the present time have been more than sufficient to pay for the entire installation of all necessary equipment for compressing and returning gas to the producing formation."

"OK, Mr. Bennett", we say, "I know when I am whipped. I am convinced that competent petroleum engineers can forecast reservoir performance and lifting costs for various production processes and that upon the basis of these estimates a decision can be made of the most profitable process for a particular reservoir. How about showing me what such an economic analysis would look like. I would like to see what I could learn from one."

Mr. Bennett's reply to this is purely conjectural, but it might be as follows: "Well son, I don't happen to have one handy, but a couple of years ago a very capable petroleum engineer, named van Wingen, made such an analysis based upon published reservoir data and presented it at an A.I.M.E. meeting[4]. Why don't you look that up?"

To anyone interested in the economics of gas injection, no better advice could be given, but in considering Mr. van Wingen's paper, it is important to keep this thought in mind: The method of analysis proposed is applicable to any injection project, the figures apply to one hypothetical project, and to that project only to the extent that his basic assumptions hold true.

He has compiled financial and operating statistics for four possible means of producing the hypothetical reservoir. These consist of production by natural depletion and by three cases involving gas injection. In the first of these, 50 per cent of the solution gas produced is returned to the reservoir. The remainder is either sold or used as fuel. In the second case, all available solution gas is returned to the reservoir. Gas in an amount equal to 48.5 per cent of this is purchased and also injected. In the third case, all available solution gas, plus purchased gas in an amount equal to 102 per cent of the available solution gas, is injected.

The behavior of the reservoir during production by these four means is shown in Fig. 1 and the production rate forecast for the various means are shown in Fig. 2, both reproduced from van Wingen. Certain of van Wingen's data is shown in Table 1, and other data computed from his is shown in Table 2.

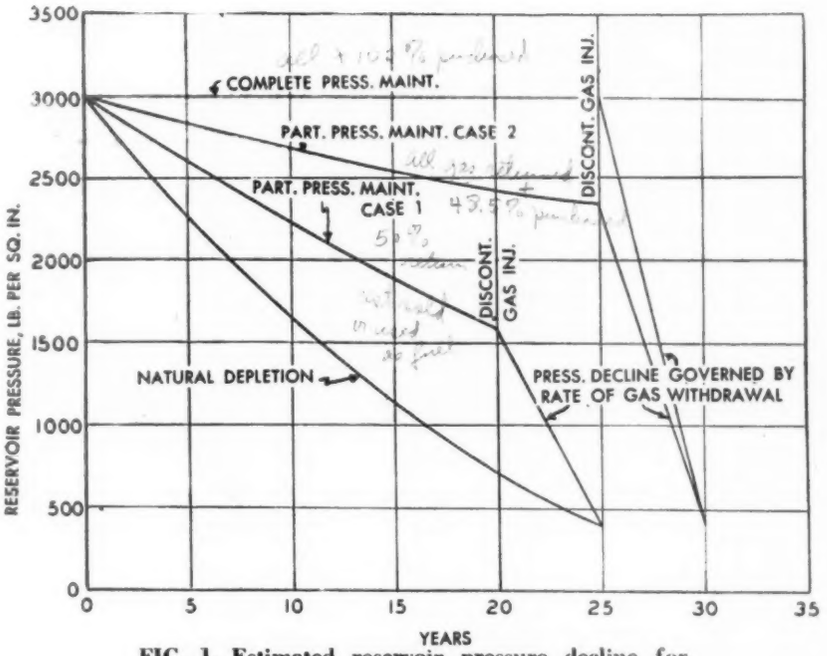


FIG. 1. Estimated reservoir pressure decline for various degrees of pressure maintenance.

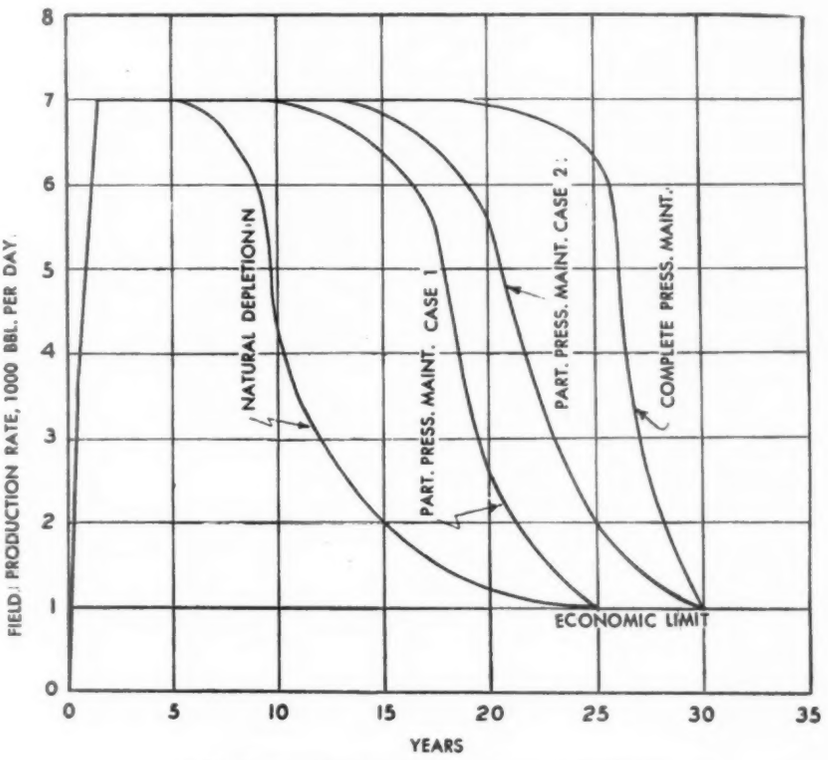


FIG. 2. Production curves. (Van Wingen)

Certain of van Wingen's basic assumptions for the hypothetical reservoir studied will be of particular interest to gas men. They are as follows:

1. The average gasoline content of the gas will be 1 gal. per M. for all cases considered.

2. The gas injected into the reservoir will be produced after the end of the injection program. It will have become enriched by contact with reservoir fluids and will also have a gasoline content of 1 gal. per M. and, therefore, require processing.

3. Total fuel plus plant shrinkage will be equal to 15 per cent of the wet gas processed.

4. Both purchases and sales will be at 7 per cent per M. cu. ft.

With these assumptions in mind, and remembering that the figures are for a particular case only, look at Table 1.

The figures in the first two lines of columns 1 and 2 indicate conclusively the profit to be gained by injecting a

portion of the solution gas. Columns 3 and 4 also indicate that the injection of purchased gas is profitable, but the profits will be less than those shown if it is necessary to pay more than 7 cents per M. cu. ft. for the gas. It is interesting to note that pressure maintenance increases gas recovery as well as oil recovery. For the case of complete pressure maintenance, the increase amounts to 23.3 per cent of the gas purchase.

Table 2 presents the data of Table 1 on a unit basis for those of us who have not yet become accustomed to thinking in terms of billions. Your attention is directed to the last item in particular, the M. cu. ft. of injection gas required per barrel of oil increase over recovery by natural depletion. Think of it the next time you look at your gas sales.

We have reviewed the opinions of two capable petroleum engineers on the subject of production. You will note that both van Wingen and Bennett are in substantial agreement concerning the the maximum ultimate recovery factor possible with pressure maintenance and the relative increase in production over that to be expected with production by natural depletion. The testimony of other experts also supports this view.

It is also indicated by the last item of Table 2 that it might be possible to pay more for the purchased gas and still not exceed the production cost per barrel by natural depletion.

The existence of such opportunities for profit and increased recovery is a challenge to the petroleum industry to reach agreements that will make production under pressure control possible, and to make available the injection gas required.

Direct purchases from gas companies or producers of dry natural gas is the most obvious possibility, if such purchases can be made economically. In this field, though, the oil producer must compete with the domestic and industrial consumer of natural gas. Some gas companies might be interested in working out long-term agreements for the storage of surplus gas. The development of dry natural gas reserves for use in injection projects is sometimes possible.

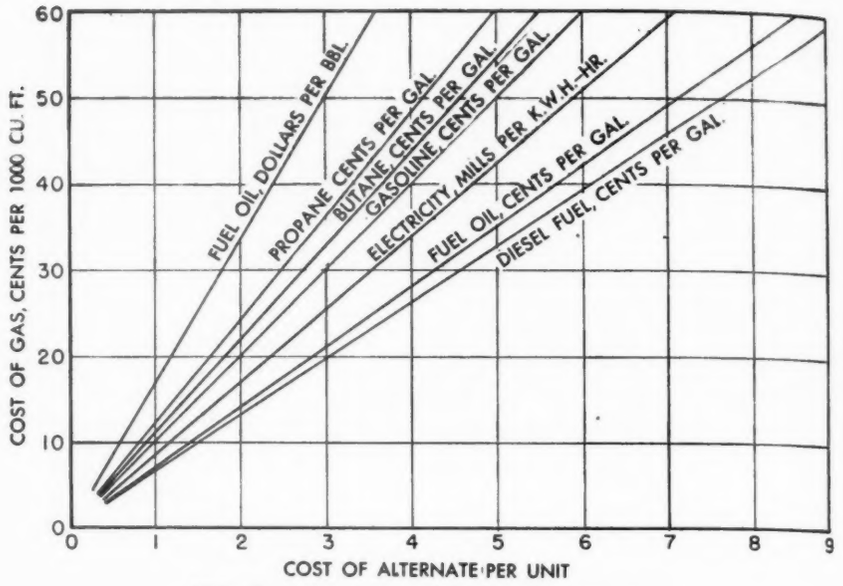


FIG. 3. Comparison of fuel and power costs

A considerable amount of gas can be made available by using it more efficiently in development and production operations. Internal-combustion engines consume far less gas per horsepower hour than the conventional oil field power plant composed of boilers and steam engines. On the average it will be from 80 to 90 per cent less.

Of course, if diesel power is substituted, the saving is 100 per cent. Or fuel oil could be substituted for gas. The lease agreement might permit the operation of a small plant for the production of royalty-free diesel or fuel oil for development and production work. And speaking of that, aren't there refinery operations that produce gas as a by-product? Perhaps we could get our refinery department to conduct certain cracking operations in the field. Speaking of cracking, didn't the gas companies at one time crack natural gas and obtain an increase in volume? Perhaps that might be practical. And what about the manufacture of chemicals from natural gas and petroleum? Do any of those processes produce by-product gases suitable for injection?

An amazingly large number of sources suggest themselves. The question of determining which sources have economic possibilities depends upon the value that can be assigned to the gas as an injection medium and the magnitude and expected life of the particular project. If the gas comes from a manufacturing operation, the value of associated products must be considered. In addition, the physical and chemical properties of the manufactured gas must be considered.

It is of primary importance that the gas be harmless to the reservoir and to the producing facilities. Its specific volume at reservoir pressure and temperature should be high. Unless the oil in the reservoir is high in viscosity, the gas should be relatively insoluble in the reservoir liquid phase, for free gas occupies a far greater volume than gas in solution. Moreover, some reservoir liquids, when diluted, precipitate asphalt-like subsubstances that tend to impede the flow of fluid and reduce recovery. The presence of constituents in the gas not native to the reservoir may be advantageous since it would permit the detection of injection gas in well effluent in case of bypassing. A further important consideration is that the gas remaining in the reservoir be suitable for use as fuel if it is to be sold at the end of the operation.

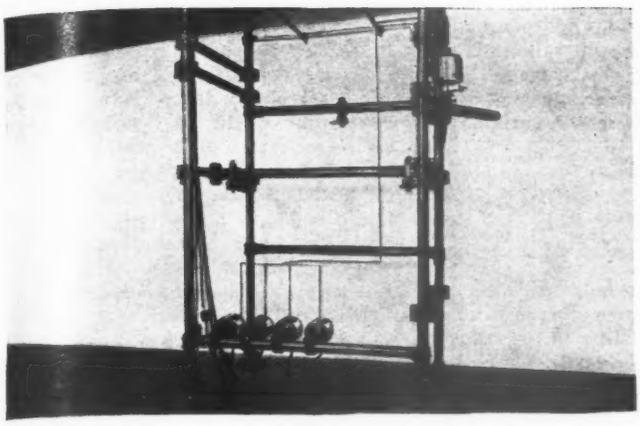
In secondary recovery operations, air is sometimes used as an injection gas but even at the low pressures required

Table 1. Analysis of data for various methods of exploitation.

Item	Method of exploitation			
	Natural depletion	Pressure maintenance		
		Partial		Complete
		Case 1	Case 2	
Net profit after all costs and royalties (millions)	$25.751	$40.664	$49.938	$59.373
Net profit after all costs and royalties discounted for present worth at 6 per cent (millions)	$14.651	$20.312	$22.296	$24.078
Oil reserves, bbl. (millions)	33.0	48.6	57.6	67.8
Gas reserves M. cu. ft. (millions)	62.141	66.770	69.470	72.500
Oil recovery factor, per cent	25.6	37.7	44.7	52.5
Total injected gas M. cu. ft. (millions)		20.060	43.665	81.265
Gas purchases M. cu. ft. (millions)			15.865	44.332

Table 2. Comparison of data for various methods of exploitation.

Item	Method of exploitation			
	Natural depletion	Pressure maintenance		
		Partial		Complete
		Case 1	Case 2	
Average daily gas processed, M. cu. ft.	6805	9509	10325	14033
Average daily gasoline production, gal.	6805	9509	10325	14033
Average daily injection rate, M. cu. ft.		2746	4782	8900
Average daily gas purchases, M. cu. ft.			1737	4855
Increase in oil recovery over recovery by natural depletion				
Bbl. (millions)		15.6	24.6	34.8
Per cent		47.3	74.6	105.5
Total production costs, cents per bbl. of oil recovered	28.8	22.8	21.2	22.4
M. cu ft. gas injected per bbl. of oil recovered over recovery by natural depletion		1.28	1.78	2.34



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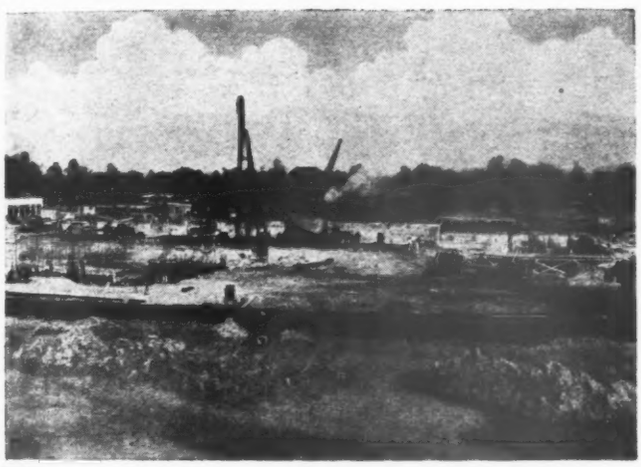

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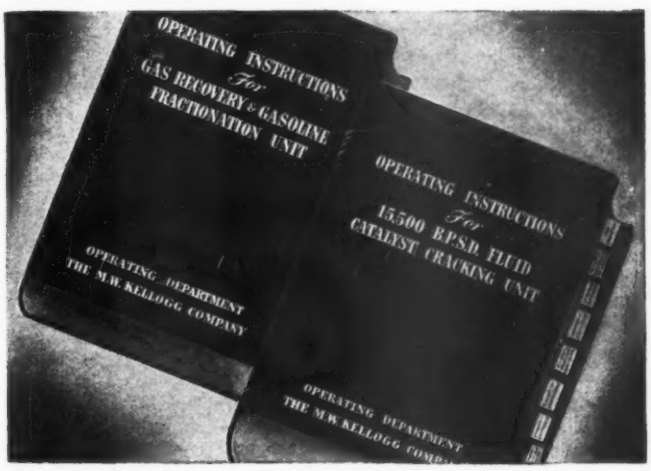

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portion of the solution gas. Columns 3 and 4 also indicate that the injection of purchased gas is profitable, but the profits will be less than those shown if it is necessary to pay more than 7 cents per M. cu. ft. for the gas. It is interesting to note that pressure maintenance increases gas recovery as well as oil recovery. For the case of complete pressure maintenance, the increase amounts to 23.3 per cent of the gas purchase.

Table 2 presents the data of Table 1 on a unit basis for those of us who have not yet become accustomed to thinking in terms of billions. Your attention is directed to the last item in particular, the M. cu. ft. of injection gas required per barrel of oil increase over recovery by natural depletion. Think of it the next time you look at your gas sales.

We have reviewed the opinions of two capable petroleum engineers on the subject of production. You will note that both van Wingen and Bennett are in substantial agreement concerning the the maximum ultimate recovery factor possible with pressure maintenance and the relative increase in production over that to be expected with production by natural depletion. The testimony of other experts also supports this view.

It is also indicated by the last item of Table 2 that it might be possible to pay more for the purchased gas and still not exceed the production cost per barrel by natural depletion.

The existence of such opportunities for profit and increased recovery is a challenge to the petroleum industry to reach agreements that will make production under pressure control possible, and to make available the injection gas required.

Direct purchases from gas companies or producers of dry natural gas is the most obvious possibility, if such purchases can be made economically. In this field, though, the oil producer must compete with the domestic and industrial consumer of natural gas. Some gas companies might be interested in working out long-term agreements for the storage of surplus gas. The development of dry natural gas reserves for use in injection projects is sometimes possible.

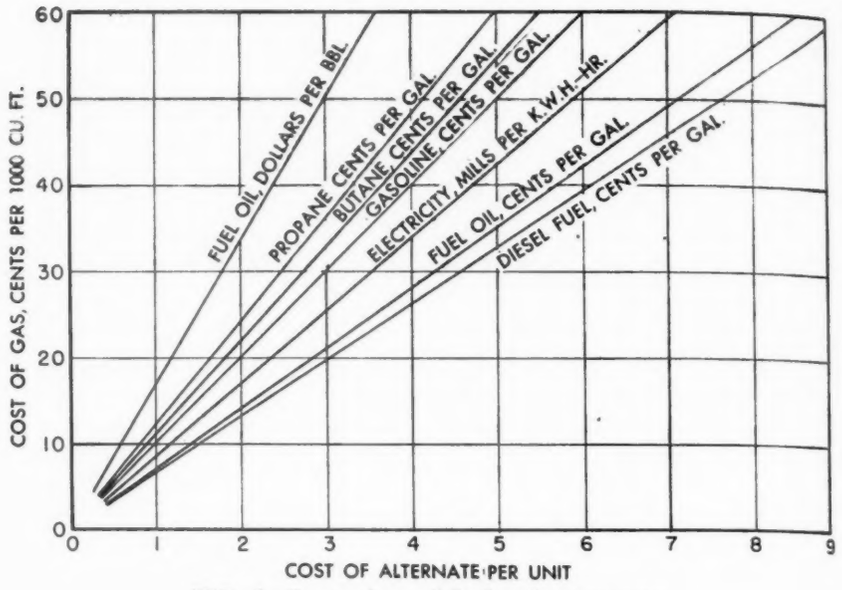


FIG. 3. Comparison of fuel and power costs

A considerable amount of gas can be made available by using it more efficiently in development and production operations. Internal-combustion engines consume far less gas per horsepower hour than the conventional oil field power plant composed of boilers and steam engines. On the average it will be from 80 to 90 per cent less.

Of course, if diesel power is substituted, the saving is 100 per cent. Or fuel oil could be substituted for gas. The lease agreement might permit the operation of a small plant for the production of royalty-free diesel or fuel oil for development and production work. And speaking of that, aren't there refinery operations that produce gas as a by-product? Perhaps we could get our refinery department to conduct certain cracking operations in the field. Speaking of cracking, didn't the gas companies at one time crack natural gas and obtain an increase in volume? Perhaps that might be practical. And what about the manufacture of chemicals from natural gas and petroleum? Do any of those processes produce by-product gases suitable for injection?

An amazingly large number of sources suggest themselves. The question of determining which sources have economic possibilities depends upon the value that can be assigned to the gas as an injection medium and the magnitude and expected life of the particular project. If the gas comes from a manufacturing operation, the value of associated products must be considered. In addition, the physical and chemical properties of the manufactured gas must be considered.

It is of primary importance that the gas be harmless to the reservoir and to the producing facilities. Its specific volume at reservoir pressure and temperature should be high. Unless the oil in the reservoir is high in viscosity, the gas should be relatively insoluble in the reservoir liquid phase, for free gas occupies a far greater volume than gas in solution. Moreover, some reservoir liquids, when diluted, precipitate asphalt-like substances that tend to impede the flow of fluid and reduce recovery. The presence of constituents in the gas not native to the reservoir may be advantageous since it would permit the detection of injection gas in well effluent in case of bypassing. A further important consideration is that the gas remaining in the reservoir be suitable for use as fuel if it is to be sold at the end of the operation.

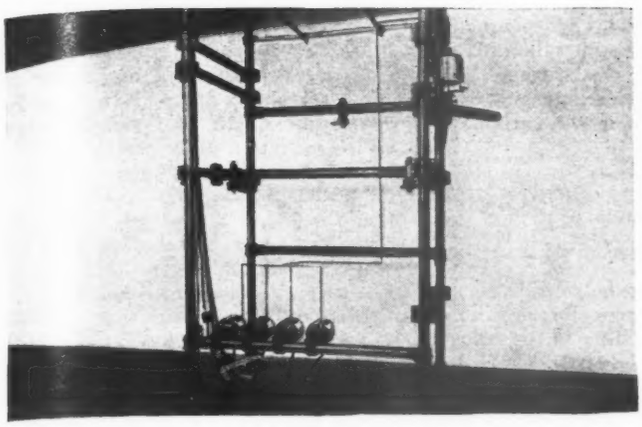
In secondary recovery operations, air is sometimes used as an injection gas but even at the low pressures required

Table 1. Analysis of data for various methods of exploitation.

Item	Method of exploitation			
	Natural depletion	Pressure maintenance		
		Partial		Complete
		Case 1	Case 2	
Net profit after all costs and royalties (millions)	$25.751	$40.664	$49.938	$59.373
Net profit after all costs and royalties discounted for present worth at 6 per cent (millions)	$14.651	$20.312	$22.296	$24.078
Oil reserves, bbl. (millions)	33.0	48.6	57.6	67.8
Gas reserves M. cu. ft. (millions)	62.141	66.770	69.470	72.500
Oil recovery factor, per cent	25.6	37.7	44.7	52.5
Total injected gas M. cu. ft. (millions)		20.060	43.665	81.265
Gas purchases M. cu. ft. (millions)			15.865	44.332

Table 2. Comparison of data for various methods of exploitation.

Item	Method of exploitation			
	Natural depletion	Pressure maintenance		
		Partial		Complete
		Case 1	Case 2	
Average daily gas processed, M. cu. ft.	6805	9509	10325	14033
Average daily gasoline production, gal.	6805	9509	10325	14033
Average daily injection rate, M. cu. ft.		2746	4782	8900
Average daily gas purchases, M. cu. ft.			1737	4855
Increase in oil recovery over recovery by natural depletion				
Bbl. (millions)		15.6	24.6	34.8
Per cent		47.3	74.6	105.5
Total production costs, cents per bbl. of oil recovered	28.8	22.8	21.2	22.4
M. cu ft. gas injected per bbl. of oil recovered over recovery by natural depletion		1.28	1.78	2.34



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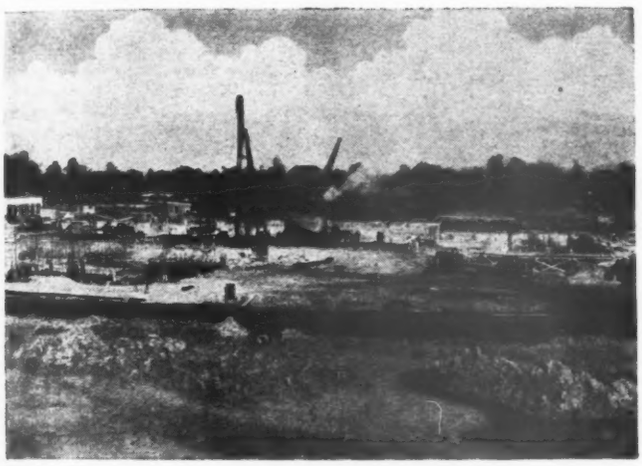

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for this work difficulty is experienced with oxidation. The use of combustion products from internal-combustion engines has been suggested[10] as a means of eliminating oxidation trouble. The controlled combustion of natural gas-air mixtures over a catalyst has also been suggested[11] as a means of preparing a suitable gas. In this latter method the heating value of the resultant gas is maintained at a proper value if the product is to be ultimately used as fuel. It is possible that such a process might be applicable to the production of gas for pressure maintenance purposes.

The reactions of methane or ethane with steam also produce large volumes of gas that would be suitable for injection.

It would appear that processes that give increased volumes of gas together with a valuable by-product would have the greatest economic possibilities. This does not necessarily mean that the hydrocarbon processed must be a gas, however. It would also appear that the processes, with the exception of those previously mentioned, would be limited to those in which the hydrocarbon is subjected to thermal cracking.

When hydrocarbons are subjected to thermal cracking, or pyrolysis, the lower molecular hydrocarbons may be formed, or the hydrocarbon molecule may be completely reduced to carbon and hydrogen. In this latter case one mole of hydrocarbon of the general formula C_nH_{2n+2} will yield (n+1) moles of hydrogen. In terms of volume, if the hydrocarbon is a gas, this means that one standard cubic foot of gas of formula C_nH_{2n+2} will yield (n+1) standard cubic feet of hydrogen.

The volumetric behavior of a particular gaseous component in a high-pressure reservoir cannot be predicted without an accurate quantitative knowledge of the other components with which it is to be mixed; but in general it can be stated that equal volumes of hydrogen, methane, ethane, propane, and butane, measured at atmospheric conditions, would not occupy equal volumes at reservoir conditions. From data by Sage and Lacey[5] as applied to a typical plant residue dry gas, the volumes occupied by one pound mole of each of the gaseous constituents has been estimated for an assumed reservoir condition of 190°F. and 3000 lb. per sq. in. abs. One pound mole is that quantity of a gas which exactly occupies a volume of 379.5 std. cu. ft. The volume given here for hydrogen was estimated from a compressibility factor chart using the pseudo critical constant suggested by Newton[6].

	Estimated partial molal volume of various gases in the reservoir in cu. ft. at 190° F. and 3000 lb. per sq. in. abs.
Hydrogen	2.62
Methane	2.16
Ethane	1.01
Propane	1.00
Butane	0.26

On the basis of the above data, the volume occupied in the reservoir by one pound mole of the various hydrocarbons can be compared with the volume that would be occupied by the hydrogen obtained by completely decomposing the hydrocarbon to hydrogen and carbon.

Constituent	Volume of constituent	Volume of released hydrogen
Methane	2.16	5.24
Ethane	1.01	7.86
Propane	1.00	10.48
Butane	0.26	13.10

Another property to be considered in evaluating various gases for injection purposes is their solubility in the reservoir liquid phase. Unless it is desired to lower the viscosity of the liquid phase, greater benefit will be obtained by using a gas of low solubility.

No generally valid comparison can be made of the solubilities of the various gases; however, if the equilibrium constants are compared, a rough idea can be gained of relative solubilities. The constants used in preparing the following table were those of Katz and Hachmuth[12].

Constituent	Relative solubility based on equilibrium constants at 190° F. and 3000 lb. per sq. in. abs.
Methane	1
Ethane	2.3
Propane	3.2
Butane	5.0

No data are available for hydrogen at the same conditions. Kirkbride[13] gives data indicating that at 800 lb. per sq. in. the equilibrium constant for hydrogen would be about one-fourth that of methane.

Thermal cracking processes in which the hydrocarbon molecule is only partially decomposed also have possibilities. For examples, the pyrolysis of ethane to produce methane and hydrogen, propane to produce ethylene and methane, and butane to produce propylene and methane. These reactions are shown below in the order of reference. The figures in parenthesis are the estimated partial molal volumes at reservoir conditions.

(a) C_2H_6 (1.01)→CH_4 (2.16) + H_2 (2.62) + C

(b) C_3H_8 (1.00)→CH_4 (2.16) + C_2H_4

(c) C_4H_{10} (0.26)→CH_4 (2.16) + C_3H_6

No partial molal volumes were estimated for ethylene and propylene since they would probably be removed as a valuable product before the gas was injected. Even so, it will be noted that a substantial increase in volume has been obtained.

In a commercial operation involving reactions (b) and (c), products other than those shown would be obtained. Perkins[7] shows the following products and yields from the thermal polymerization of propane, butane and a propane butane mixture.

Products wt. per cent	Propane	Butane	50% propane 50% butane
Gasoline	55.0	66.0	60.8
Tar	—	4.3	2.3
Dry gas	45.0	29.7	36.9
	100.0	100.0	100.0

Perkins discussions will be of considerable interest to anyone investigating the economies of this subject.

It has also been proposed to use as an injection gas the by-product nitrogen from the generation of oxygen for the Fischer-Tropsch process[8] and a hydrogen-halide containing residue gas from an isomerization process[9].

The principal point to be gained from this discussion of pyrolysis is that it would seem to be entirely possible to remove propane and butane from natural gas, thermally crack the propane and butane, and recover from the process valuable by-products and a volume of gas which will occupy a greater volume in the reservoir than would have been occupied by the propane and butane removed. If natural gas is used as fuel for the cracking operation, however, the effect of this on the gas balance must be considered.

One further word. When considering the substitution of fuel oil or other fuels for natural gas, the cost relationships between the two must be considered. This is shown in Fig. 3. The conversion factors used were as follows:

Gasoline	0.1 gal. per b. hp-hr.
Butane	same thermal efficiency as natural gas
Diesel fuel	0.45 lb. per b. hp-hr.
Natural gas (1100 B.t.u. per cu. ft.)	10 cu. ft. per b. hp-hr.
Propane	same thermal efficiency as natural gas
Fuel oil	6,000 cu.ft. natural gas per bbl. oil
Electrical power	88 per cent efficiency

Now, for a quick review. The statements of two experts on pressure-maintenance operation have been referred to. Both of these support the view that the greatest possible ultimate recovery of oil from a reservoir will be obtained by maintaining the reservoir at its original pressure. To maintain the initial pressure it is necessary to return to the formation all gas produced plus enough additional gas to occupy the space containing the liquid volume of the oil withdrawn. Several possible sources for obtaining this gas have been discussed.

Whether these sources of gas can be profitably utilized depends upon the source of the gas, the magnitude of the operation, and the characteristics of the particular reservoir being investigated.

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13. Kirkbride, C. G., *Petroleum Refiner*, 24 (11) (1945).

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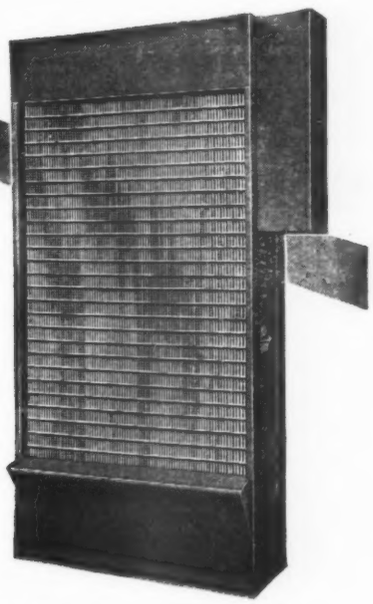

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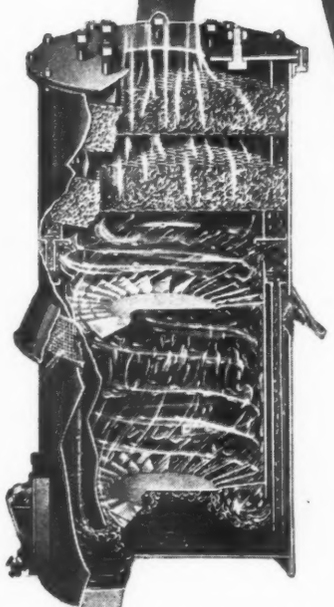

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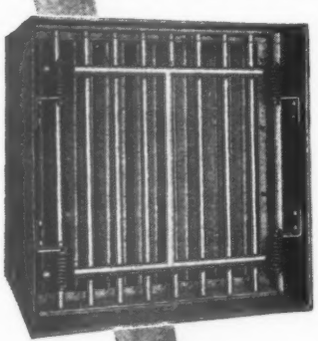

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Practical application of geology to reservoir analysis

By **WALLACE W. WILSON**
Ryder-Scott Company*

● **Introduction.** Petroleum engineers and geologists engaged in the study of oil-producing sandstone reservoirs are frequently handicapped by a lack of information regarding the detailed geology of the producing formation with which they are concerned. The correct interpretation of observed reservoir conditions may depend almost entirely upon adequate knowledge of the structure, physical characteristics, and continuity of the individual porous members of the producing formation.

EXCLUSIVE

The geology of sandstone reservoirs frequently is complex, particularly when they are of limited areal extent compared with the overlying and underlying rocks. In such cases, the producing formation usually may be shown to be the result of a localized depositional environment. Offshore bars, deltas, beach veneers, and lagoonal deposits, all of which were formed in localized areas, are typical examples of this type of reservoir. The accumulation of oil within such formations, and its subsequent production, usually is controlled to a considerable extent by the continuity and physical characteristics of the individual porous members.

This article was prepared as an example of a detailed geological study of a producing formation, in an area now being water-flooded. This discussion necessarily was limited to one rather large property, because the data necessary for the study of nearby areas were not available.

The Ralph property comprises about 5000 acres, a large part of which is within the productive limits of the Kanesholm pool, in the southwest part of McKean County, Pennsylvania. Oil production is from the Bradford Third sand; gas is produced locally from the Fourth, Kane, and other sands both above and below the Bradford Third sand.

The relationship of the Kanesholm pool to the Bradford pool and other nearby productive areas is shown on Fig. 1. Sufficient information is not available, however, to determine whether the Bradford Third sand of the Kanesholm pool correlates with that at the type locality in the Bradford pool.

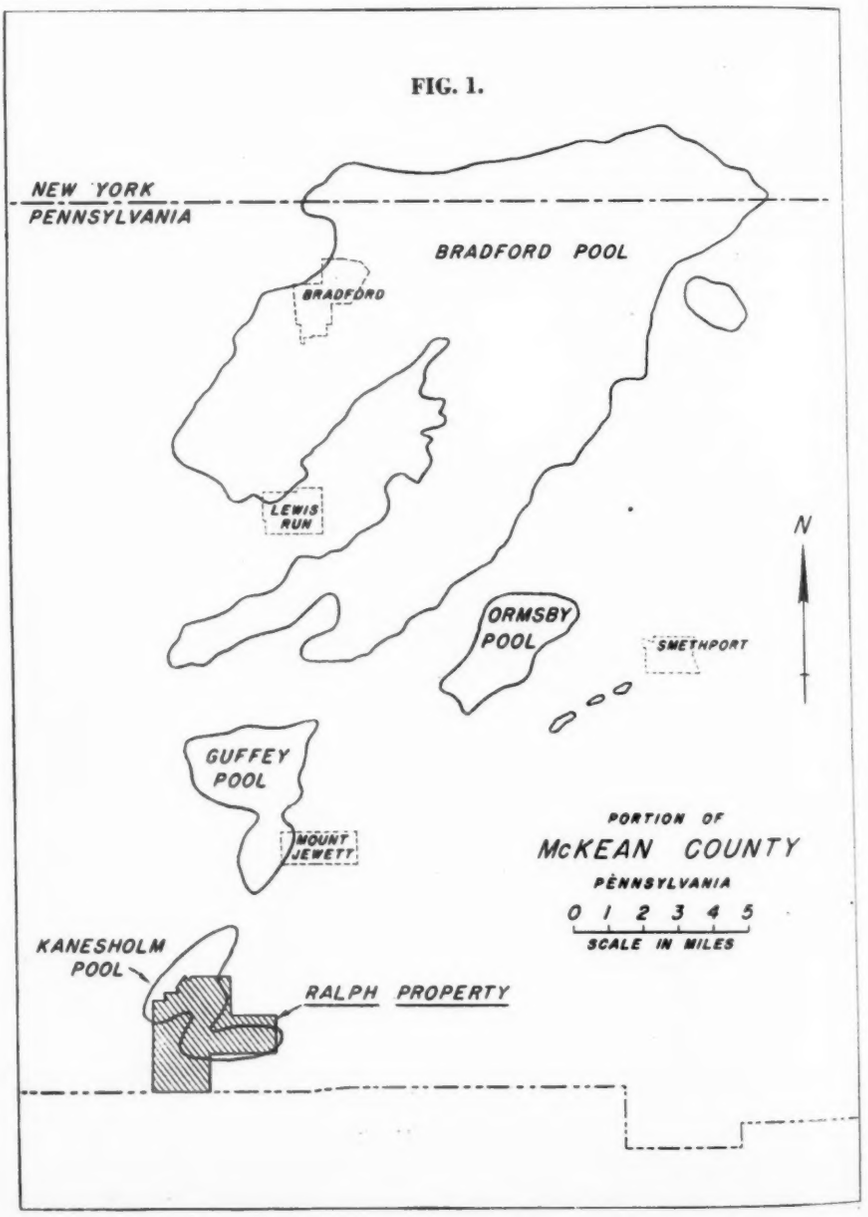
*Petroleum Engineers, Bradford, Pennsylvania.

● **History.** The first well in this area, Wilcox No. 1, was drilled in 1870, near the southeast corner of the Ralph property. This old well was drilled, uncased, to the Kane sand, which is locally gas-bearing, and is about 250 ft. below the Bradford Third sand. Commercially, the well was a failure, for it produced very little oil from the unshot Bradford Third sand; however, the well produced substantial quantities of natural gas, which was ignited occasionally for exhibition purposes, giving rise to the name "Burning Well."

Extensive drilling for natural production did not begin in this area until about 1900. After the production decline, the northern part of the property was redrilled for high-pressure water-flooding in 1929; prior to that time, only a few small-scale floods had been initiated.

Many of the new pattern wells were cored with Baker and diamond coring tools. More recently completed areas, in the northwest and southeastern parts of the property, were developed primarily on the basis of test data from "chip" cores, which were obtained at all the

FIG. 1.



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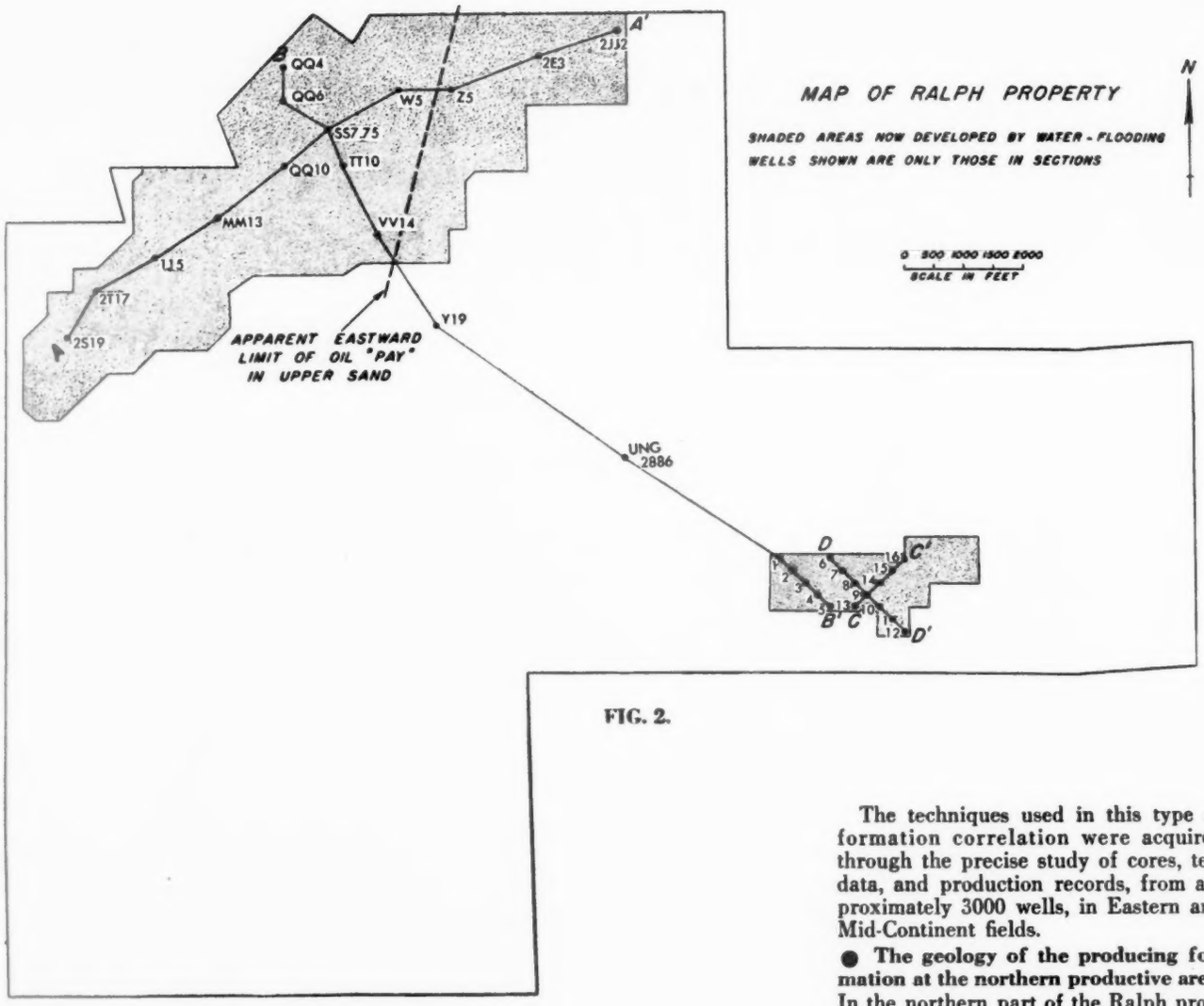

FIG. 2.

new pattern wells in those areas. In addition to the regular pattern drilling, several test wells were drilled and cored in areas already flooded, to determine the efficiency of the flooding procedures. Much important information was thus obtained that could not have been obtained in any other way.

● **Stratigraphy.** An outline of the stratigraphy of formations exposed or drilled at the Ralph property is as follows (after Fettke):

Pennsylvanian system:

Mercer coal and shale	30 ft.
Conoquenessing standstone	30-40 ft.
Sharon shale and coal	20-50 ft.
Olean conglomerate	40-50 ft.

Unconformity

Mississippian system:

Knapp formation	100-150 ft.

Devonian system:

Oswayo formation	200 ft.
Cattaraugus formation	300 ft.
Chemung formation (Petroliferous)	about 2000 ft.

All oil-bearing strata are confined to the Chemung formation, the full depth of which has not been drilled in the deepest wells on the property.

● **Sources of information.** The sources of the data upon which this investigation is made are as follows:

1. 25 diamond cores, 63 Baker cores, and 57 chip cores, from wells on the property, with their test data.
2. The original records for some 220 old wells on the property.
3. Production records, which have been kept for all recently flooded areas, by wells and by groups of wells.

Surface elevations were obtained at all of the cored wells used in the sections. From the elevations and the core logs, it was possible to construct several sections through the producing formation at the principal productive areas of the property. The sections were constructed to show the apparent continuity of the principal sand and shale members within the producing formation. The distance between cored wells determines, to a large extent, the detail with which this correlation can be made.

Some of the more important factors used in this type of correlation are:

1. The oil and water content of the individual sand layers. The effects of prior flood activity can be traced for some distance in continuous sand layers.
2. Indicated lensing of certain parts of the formation.
3. Indicated facies change within the formation.
4. The physical characteristics of the sand and shale, based on the sand test data, and inspection of the cores.

The techniques used in this type of formation correlation were acquired through the precise study of cores, test data, and production records, from approximately 3000 wells, in Eastern and Mid-Continent fields.

● **The geology of the producing formation at the northern productive area.** In the northern part of the Ralph property, the Bradford Third sand may be subdivided into two zones, which may represent different, but related, stages of deposition. The upper zone is represented by the upper 25 ft. of sand at well 2JJ2, (section AA', Fig. 3). The lower zone at that well is represented by the sand and shale layers in the remainder of the cored section.

The upper zone consists of between 1 and 25 ft. of fine-grained sand, with occasionally localized thin shale layers. The sand has a porosity range of about 10 to 20 per cent; air permeability values range between about 0.5 to 30 millidarcies. This sand body appears to be the southwestern tip of an offshore bar or beach deposit, extending for an unknown distance northeastward. There is some evidence that this sand body becomes much thinner not far beyond the northeastern limits of the property, although the data are not conclusive. The indicated structure of the sand body is that of an anticline, gently plunging toward the southwest. The average dip of the top of the sand along section AA' (Fig. 3), which follows the major axis, is approximately 30 ft. per mile. On the northwest flank of the sand body, the dip of the sand top is approximately 50 ft. per mile; southward of the crest, the formation is practically flat (section BB', Fig. 4). The upper sand zone lenses out

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- ☐ Wire Rope Lubrication

FIG. 3.

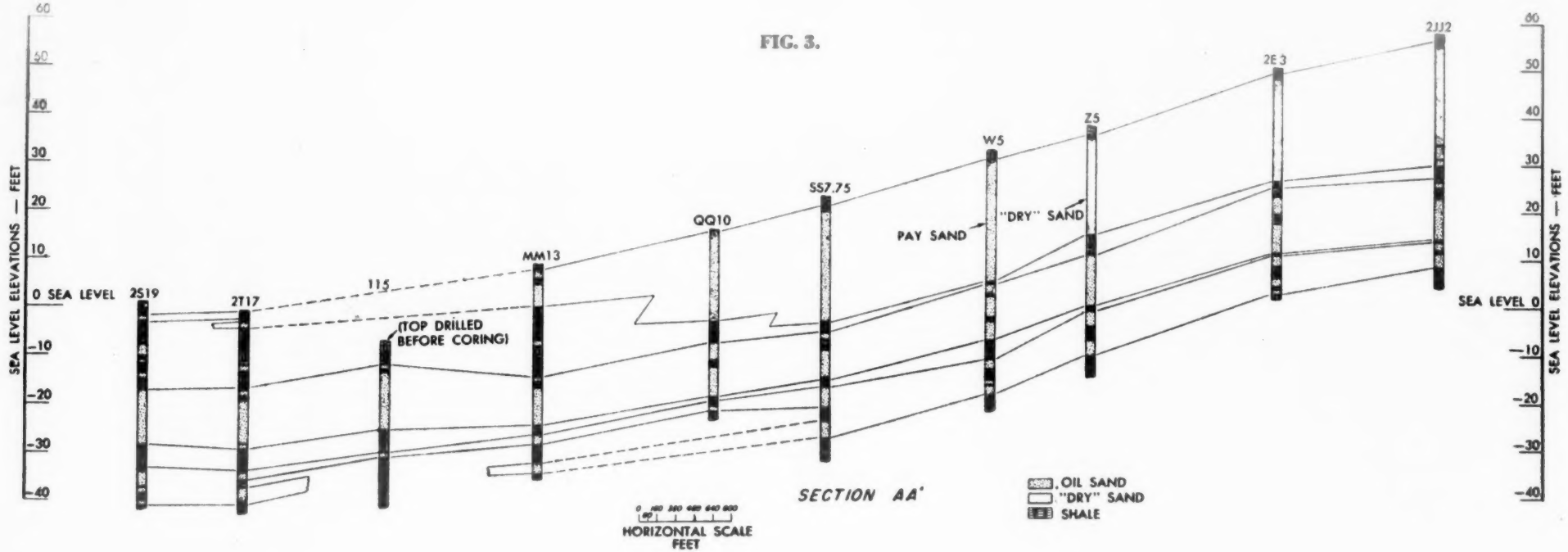
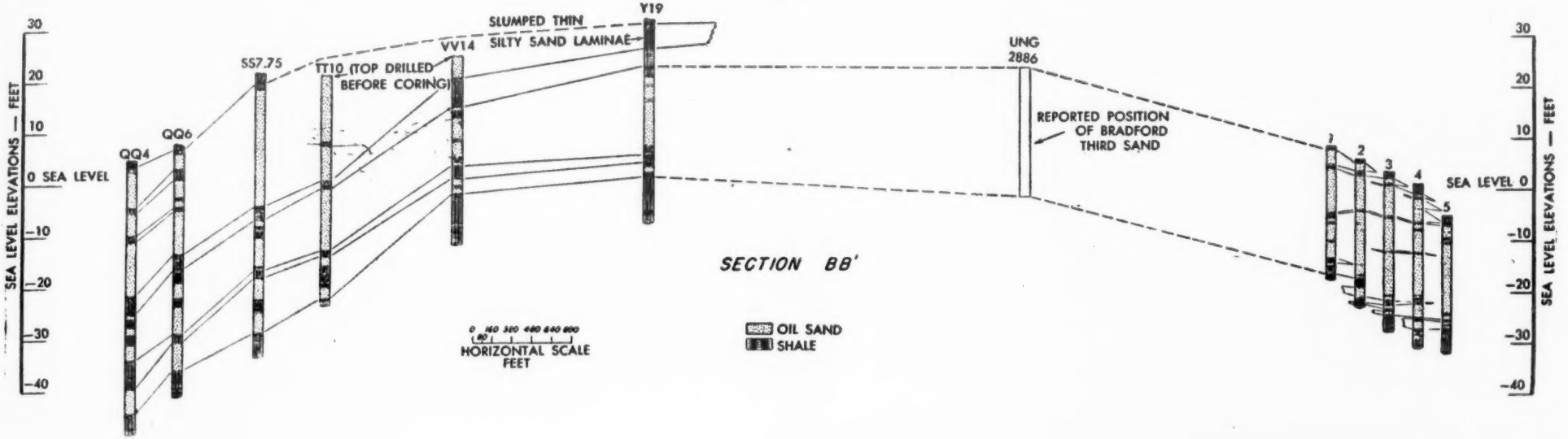
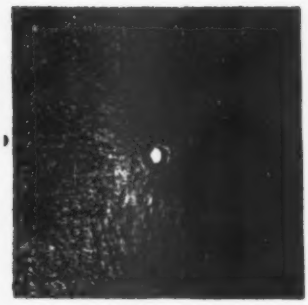

SEA LEVEL ELEVATIONS — FEET
60
50
40
30
20
10
0 SEA LEVEL
-10
-20
-30
-40
2S19
2T17
115
(TOP DRILLED BEFORE CORING)
MM13
QQ10
SS7.75
PAY SAND
W5
"DRY" SAND
Z5
2E3
2JJ2
SEA LEVEL 0
HORIZONTAL SCALE FEET
SECTION AA'
OIL SAND
"DRY" SAND
SHALE

FIG. 4.


SEA LEVEL ELEVATIONS — FEET
30
20
10
0 SEA LEVEL
-10
-20
-30
-40
QQ4
QQ6
SS7.75
TT10 (TOP DRILLED BEFORE CORING)
VV14
SLUMPED THIN SILTY SAND LAMINAE
Y19
UNG 2886
REPORTED POSITION OF BRADFORD THIRD SAND
1
2
3
4
5
SEA LEVEL 0
HORIZONTAL SCALE FEET
SECTION BB'
OIL SAND
SHALE

BULLETS



This actual-size photograph of a section of 2½-inch tubing shows the clean hole made by the McCullough 1/16-inch bullet through ¼-inch steel.

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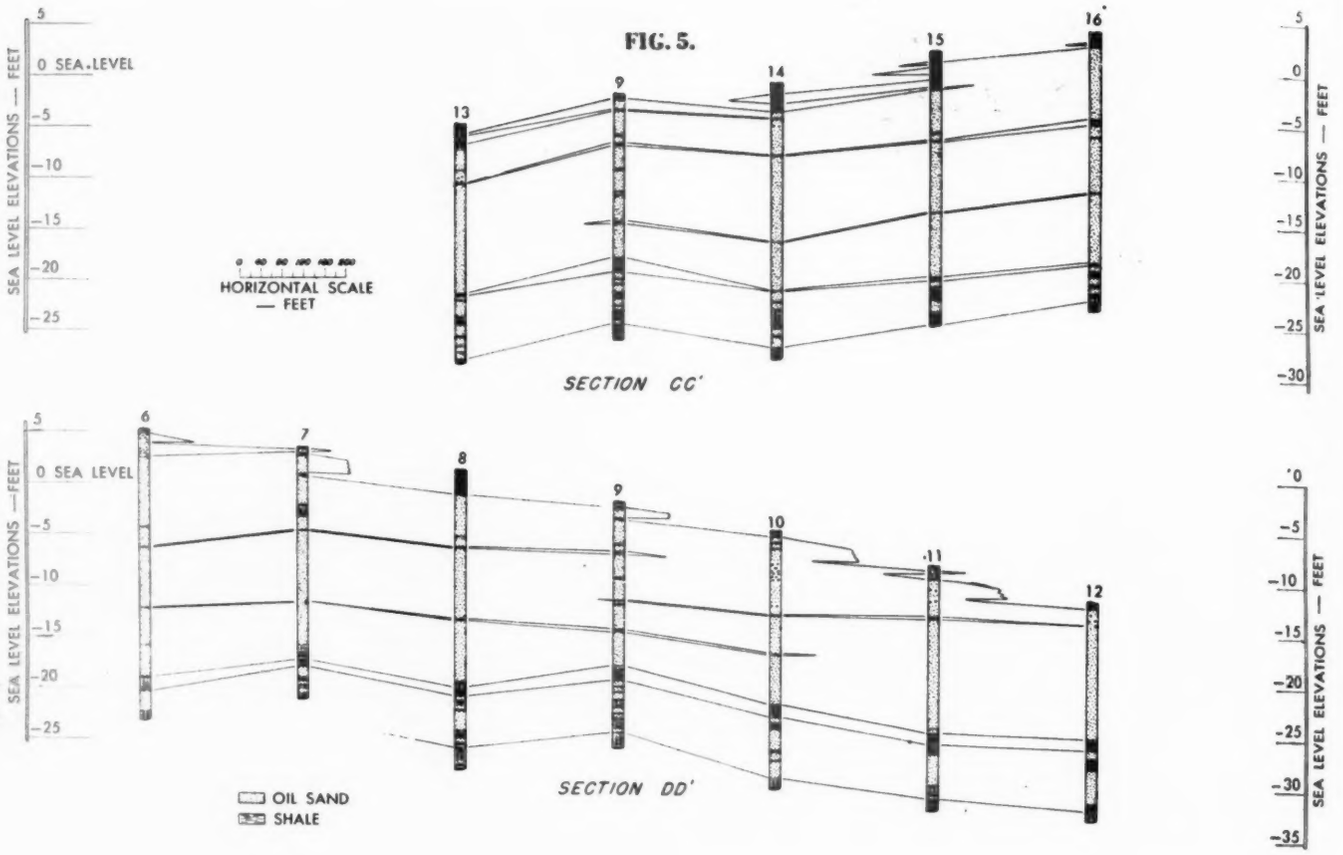
CALIFORNIA: AVENAL, BAKERSFIELD, LOS ANGELES, SACRAMENTO, VENTURA **WYOMING:** CASPER



to the south, not far beyond the southern edge of the developed area in the northern part of the property (Fig. 2). Toward the west and southwest, this sand formation thins sharply to a very tight silty sand, near the southern edge of the property (section AA', Fig. 3).

A coarse-grained, calcareous sand, locally termed conglomeratic, was found at the top of the upper sand zone, at all wells that were cored through the entire sand formation. This conglomeratic sand, however, may not extend in one continuous layer over the entire sand body. Studies of the formation in the southeastern part of the property indicate that the presence of such conglomeratic sand may be evidence of very rapid lensing of sand layers. Unfortunately, the cored wells in the northern part of the property are too widely spaced to determine the significance of the conglomeratic sand in that area.

In the north-central part of the property, the upper sand changes quite abruptly from a pay to a dry sand. This latter contains oil, but not in quantities sufficient for either natural or water-flooding production. The approximate location of this sudden change in oil content is indicated on Fig. 2. The lower sand zone is continuously productive within the area where the upper sand becomes dry.

Wells W5 and Z5 (Fig. 3) serve to illustrate this condition. All upper sand at W5 was found to be relatively highly oil-saturated, with an average oil content of approximately 50 per cent of the pore space. The oil content of the corresponding sand at Z5, with comparable porosity, is approximately 21 per cent of the pore space. Spot coring has shown that the non-productive condition of the upper sand continues beyond the limits of the property. There is no evidence that this sand body becomes pay to the northeast; as previously stated, there is some evidence that this sand thins out in that direction.

There are several possible explanations for the abrupt change in oil content observed in the upper sand, some of which will be discussed in the following paragraphs. Briefly stated, these are:

1. The dry area was formerly a high pressure gas cap, which is now exhausted.

2. The dry sand was once filled with oil, but that oil has since drained downstructure and has been produced.

3. Sufficient oil was not available from the source material to fill the entire sand body.

4. Faulting, or other intrastratal barriers, prevented the migration of any large quantity of oil into the dry area.

The available evidence indicates that the primary gas cap theory is not applicable to the observed conditions. In fact, it is very doubtful whether gravitational separation has been of primary importance in the origin of the dry area. The maximum dip of the beds, if they are assumed to parallel the dip of the top of the sand, is less than one degree. It is more probable that the actual dip of the sand itself is considerably less than the dip of the sand top. This does not appear to be sufficient to cause a separation of fluids in sand having a maximum premeability of about 30 millidarcies. It is also reported by a former owner of the property that the original drilling resulted in no substantial flow of gas from the dry sand. The original well records confirm this statement. No old wells on the property exhibited unusual flush production that might indicate high formation pressure, although original pressure measurements were not recorded.

Field experience has shown the impossibility of gravitational drainage that could result in the present fluid content of the dry sand. Mathematical calculations, based on formulae developed by Jones[1] show that only a very small quantity of oil could have drained down dip in the time since production was first obtained in this area. The present average oil saturation of the dry sand, about 20 per cent of the pore volume, is roughly equivalent to the minimum residual oil saturation that can be obtained with a very efficient water-flood in this area.

The premature exhaustion of the original source of the oil that filled the upper sand is a possible explanation for the observed conditions. As the lower sand is continuously pay within the dry area, this hypotheses necessarily would be dependent upon the separate filling of the upper and lower zones. Quantitatively, the oil content of one acre-foot of the dry sand is substantially less than that of an acre-foot of the pay upper or lower sand with equal porosity.

It is also very possible that faulting has prevented the complete filling of the dry sand. The sharp break between the

[1] "Mechanics of Production," Park J. Jones. *Oil and Gas Journal*, 1944-45.

pay and dry areas is suggestive of such a situation. This origin for the dry condition would require that the lower sand be filled prior to the faulting. There is no observed surface evidence that such a fault exists.

If the upper sand formation is a bar or beach deposit, there would have been ample opportunity during its deposition for the formation of crossbedding, disconformities, channeling, and other types of discontinuity within the apparently solid sand body. These features have been observed in most of the well cores from this area. Unfortunately, the small diameter of the cores, and the wide spacing of the cored wells in the northern part of the property make it difficult to determine the extent of these irregularities.

Examination of outcrops of Chemung age sandstones near Rushford, New York, has shown conclusively that such intrastratal barriers do exist, and that they are capable of slowing, deflecting or otherwise preventing the horizontal flow of fluids through the porous layers. Irregularly crossbedded, micaceous zones would appear to be of particular importance as traps. The sand test data from several thousand well cores has proved that micaceous laminae influence the direction and extent of fluid movements. Another fact of great importance is the commonly observed phenomenon of very micaceous, laminar sand layers having unusually low oil saturation values[2].

The connate water content of the dry sand is unusually high, averaging about 50 per cent of the pore space. This is evidenced by the core analyses, as well as by the behavior of an experimental waterflood in the dry area. This flood was a failure, since the dry sand was not productive by water-flooding; in addition, the flood resulted in the formation of large quantities of gypsum, which completely filled the tubing strings of the producing wells in a very short time. The high connate water content of the dry sand may be very significant, for it may in itself be evidence of the existence of an impermeable barrier between the pay and dry areas. In addition, it is further evidence that gravitational separation of fluids did not occur, to any appreciable extent, in this sand body.

The lower zone is composed of alternate layers of silty sand, having a permeability range of between 0 and 10 millidarcies, and soft to medium hard silts and shales. This formation appears to extend, with nearly constant thickness, to all tested portions of the property. Section BB′, (Fig. 4) was constructed to show the indicated continuity of the producing formation between the principal productive areas. The reported position of the Bradford Third sand in the driller's log of well No. UNG 2886 suggests the continuity of the lower zone horizon of the northern area with the producing formation at the southeastern part of the property.

The silt content of the sand layers in the lower zone is characeristically higher than in the upper zone; this results in generally lower permeability and a slightly lower average porosity for the lower sand. The physical character of the lower sand, and its areal extent within the property, suggest that this zone represents a separate stage of deposition from the upper zone.

The geology of the producing formation at the southeastern productive area. The development of the southeastern part of the property for production by water-flooding was begun only recently, and is not yet completed. At the present time the developed area consists of approximately 70 acres. Practically all wells in the new development were chip-cored through the producing formation, for complete core analysis. Detailed production records were obtained for the first year's operation of about 44 acres of the area. The drilling pattern was designed for 4-acre 5-spots, resulting in an average density of approximately 1½ acres per cored well. This relatively high density is not unusual for water-flooding operations; in some areas it is less than one acre per cored well. The higher density of cored wells in this part of the property permits a more detailed study of the depositional features and physical character of the sand body than could be attempted for the northern area.

In considering the structure of the

[2]D. T. May, personal communication.

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producing formation in this part of the property, it is necessary to distinguish between "specific" and "geologic" horizons. This distinction is particularly necessary in water-flooding operations. Each sand layer then reacts independently of the others, for the effect of an externally supplied, uniform pressure is directly related to the physical character of each sand layer being flooded. The continuity of individual sand layers within the producing formation is therefore a factor of major importance to the successful operation of a water-flood. In stratified producing formations, the interbedded impermeable sand and shale members will allow little, if any, vertical movement of fluids between layers at applicable field pressures. Therefore, if a sand layer that is exposed to pressure at an intake well does not extend and remain continuously permeable to the shot fracture zone of a producing well, the oil in that layer is trapped and can be recovered only by additional drilling. The loss thus sustained sometimes is of serious proportions, and has been found to be sufficient at some properties to make the development impracticable. Thus, in any competent investigation of the possibilities for water-flooding a reservoir, it is essential to determine the structure, continuity, and physical characteristics of the individual sand layers within the reservoir.

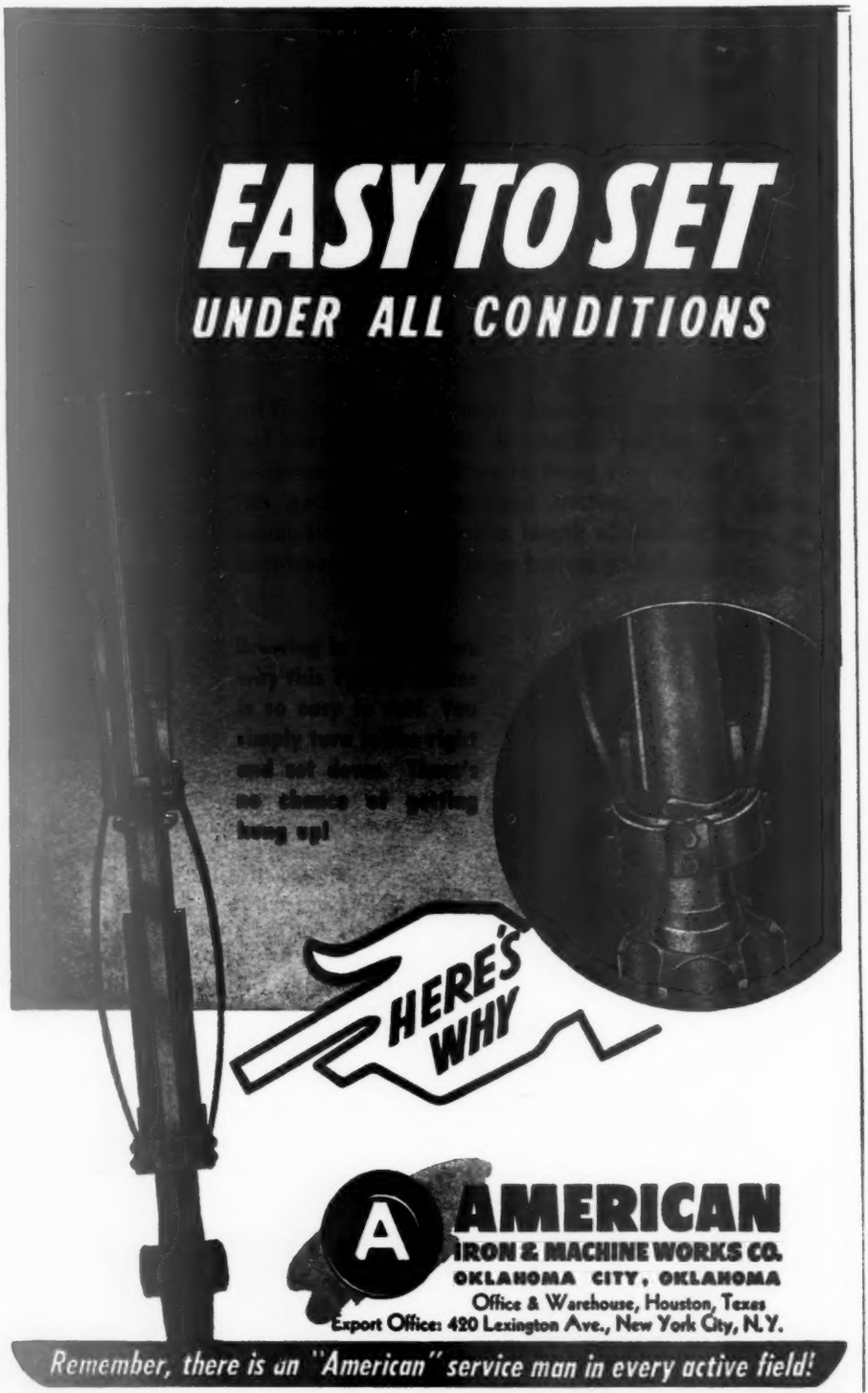
The producing formation in the southeastern part of the Ralph property is composed of a series of overlapping sand lenses, separated by thin shale layers. The sand lenses are lying almost flat, although the apparent southward dip of the top of the sand formation is approximately 63 ft. per mile. This difference in apparent dip is the result of the "shingled" attitude of the sand lenses. Sections BB′ (Fig. 4), FF′ (Fig. 5), and GG′ (Fig. 5) illustrate this condition.

Section BB′ (Fig. 4) is of particular interest, because it indicates the probable northward continuity of the sand layers encountered at the southeastern productive area. The part of the section between well No. 5 and well No. UNG-2886 shows the true attitude of the sand lenses, in comparison with the apparent dip of the entire formation, as would be indicated by the top and bottom of the sand. As this part of the section is traced from right to left, the ends of "new" sand layers appear at the top of the formation, and others thin and disappear at the bottom. It may be seen from this section that probably none, or at most only a small part, of the sand present at the southeastern productive area is continuous to well No. UNG2886. Thus, although the sand body is apparently all in the same geological horizon, little or none of the specific horizon at the southeastern area is present at well No. UNG-2886.

The producing formation at the southeastern productive area has many of the characteristics of a near-shore deposit. The "en-echelon" attitude of the sand lenses strongly suggests that deposition took place contemporaneously with shore line emergence, causing overlapping layers of sand and mud to be built up farther and farther seaward from the original shore. In this manner, the shoreward edge of each sand lens was formed at some distance seaward (northward) from that of the underlying bed. The longshore dimensions of the lenses are much greater than the width in a seaward direction. The original position of the shore at the start of the deposition of this formation is not known with certainty. The available data indicate that it is not far to the south of the developed area, and that it extended approximately east and west, possibly curving slightly northward near the eastern edge of the developed area.

The northward extent of this "shingled" type of deposition is not known. Section BB′ (Fig. 4) suggests that it may not have continued far beyond well No. UNG2886. The lower sand formation at the northern productive area is typically laminar, possibly representing a continuation of the same cycle of deposition in deeper or quieter waters offshore.

● **Discussion.** The most important application of this type of study is in determining the mobility of fluids within the reservoir. If the individual porous layers are areally extensive, and are of such physical character as to permit the free movement of fluids, reservoir forces may be determined from observed fluid movements. It may be seen, however, that the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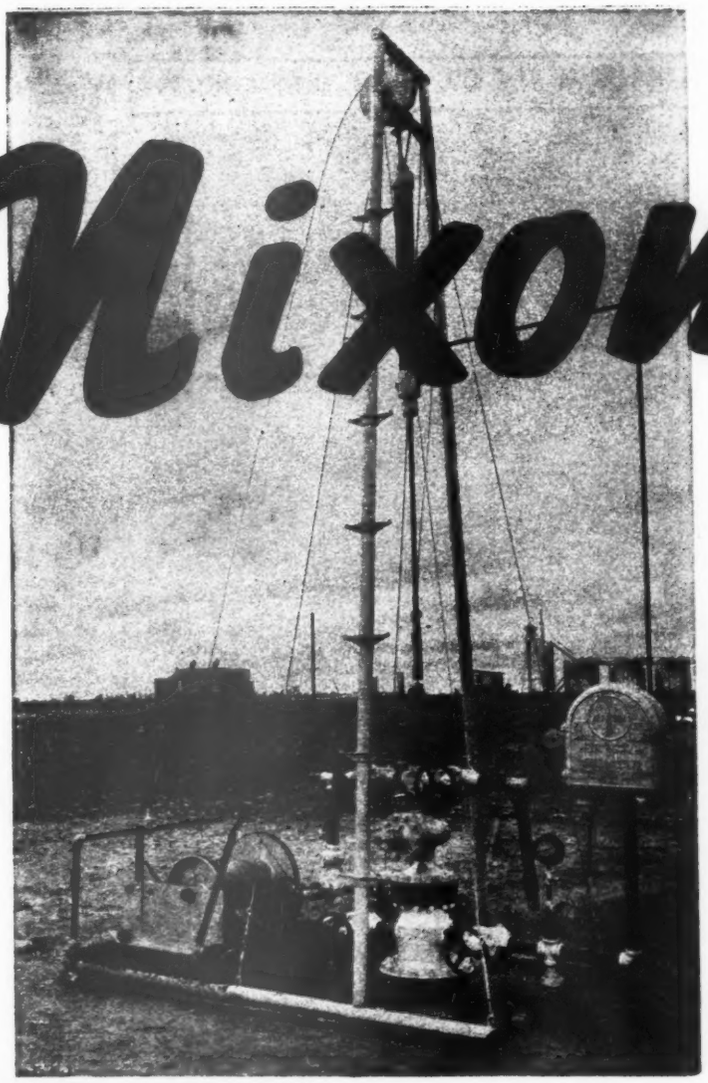

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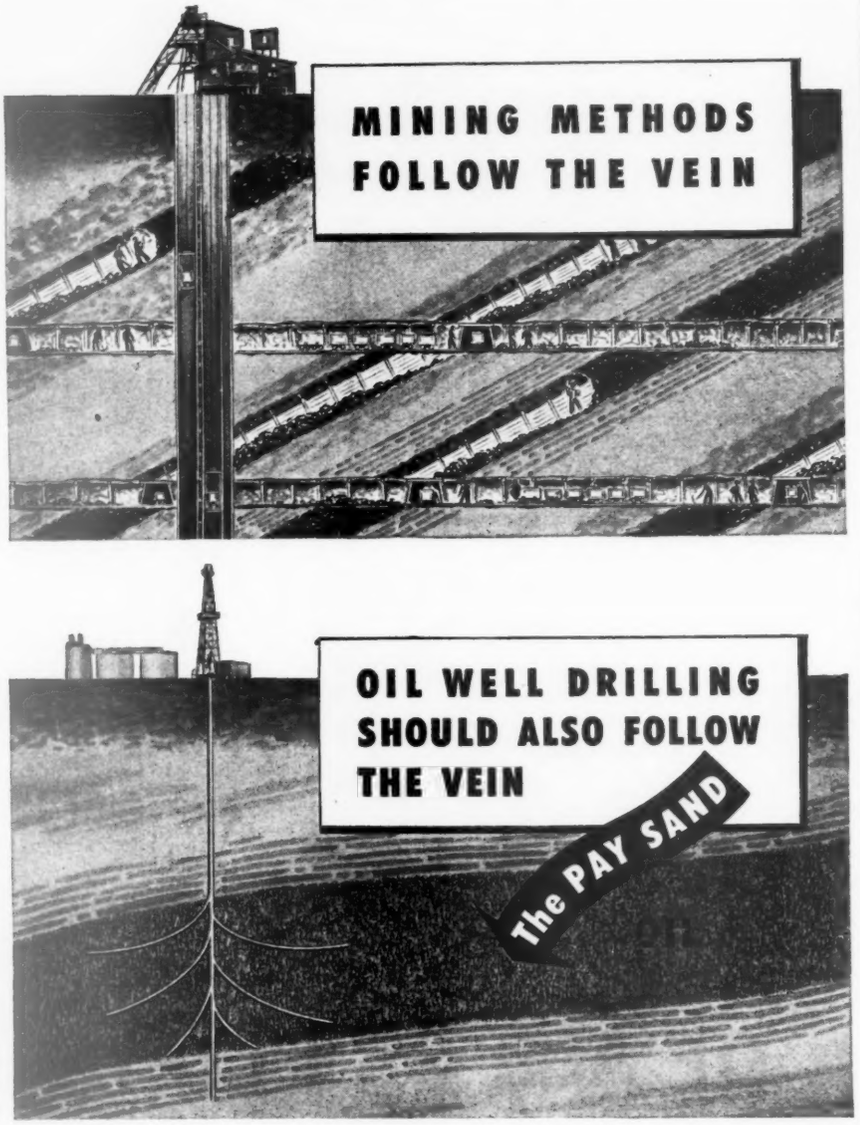

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mode of deposition of a sand producing formation can minimize the effect of the natural reservoir forces. In such cases, it may be impossible, without a detailed geological analysis, to determine the reason for the apparently anomalous reservoir behavior.

The proper evaluation of structural control in the accumulation of oil in a reservoir is a problem that is commanding the attention of many geologists and engineers at the present time. The crux of this problem has been stated by Illing[3], as follows:

"An isolated lens field discovered on an anticline would almost certainly be ascribed to the anticlinal hypothesis. Only when such a lens was discovered by a chance wildcat well far down flank or in the heart of a syncline would it receive its true explanation as a stratigraphic trap.

"Most of the structural theories depend for their validity on the ability of oil and gas to migrate with considerable freedom. Unless this can take place the value of the structures as traps cannot come into play. Therefore it is generally true that for any particular structure to perform its function as an oil trap the carrier or reservoir rocks, i.e., the portion of the sedimentary succession with sufficient permeability to allow free lateral differentiation of gas, oil and water, must extend over and beyond the limits of the structure."

Thus, according to Illing, in order to prove the existence of structural control, it is necessary to prove that the permeable sand layers extend over and beyond the limits of the structure. Detailed geological studies of the producing formation can be applied to the solution of this problem. If it can be shown, however, that the producing formation is composed of overlapping sand lenses, each with limited areal extent, the effect of structural control is subordinate to the control exerted by the sedimentary features of the sand lenses.

Studies of this type require much data, from many separate well cores and their test data, from the area under study. For this reason, areas being developed for water-flooding offer the best opportunity for similar investigations. It is the opinion of the writer that additional studies of this type might further the understanding of the origin of oil pools.

● **Acknowledgments.** The writer wishes to express his appreciation to H. M. Ryder for his many ideas and suggestions embodied in this article. The help and assistance of the members of the Ryder-Scott Company in assisting with this project are gratefully acknowledged. B. B. Cox, M. G. Gulley, W. P. Rand, and W. C. Krumbein, of the Gulf Oil Corporation, Dr. A. O. Woodford, of Pomona College, and Dr. Paul D. Krynine, of the Pennsylvania State College, offered many helpful suggestions and criticisms of the manuscript and the figures. The writer is indebted to the Ryder-Scott Company for permission to publish this article.

[3]Vincent C. Illing. *AAPG Bull.*, 29, pp. 872-884, July, 1945. ★★★

Pipe for one section of the line was coated and wrapped in a central yard. The yard shown here was at Wellborn.

Products line construction features

By **FRANK H. LOVE,** *Managing Editor*

CONSTRUCTION of Humble Pipe Line Company's 276-mile 8-in. products line from Baytown, Texas, to the Dallas-Fort Worth area has been completed insofar as laying the line pipe is concerned, and, although permanent pumping equipment cannot be installed for some months due to inability to obtain equipment and materials, temporary pumps and prime movers are making it possible to transport products through the line on a slightly restricted basis. The first delivery was started out of Baytown early this month.

EXCLUSIVE

The route of the new line follows Humble's butane-propane line from Baytown to Satsuma station northwest of Houston and from there parallels Humble's present lines to Navasota and Hearne. From the latter point the route is to a terminal north of Waco, thence north to the terminal west of Dallas.

Under the permanent set-up there will be two pumping stations, at Baytown and Hearne, and terminals at Houston, Hearne, Waco, and Dallas.

● **Line construction.** The line was laid of seamless Grade B pipe that came from the mills in double random lengths of 42 to 48 ft., weighing 28.55 lb. per linear ft. The first pipe was strung March 29, and, in general throughout construction, ditching was the con-

The stove-pipe method of construction was used throughout. Workmen are lining up and tack welding a joint of pipe.

trolling factor in progress, which is an unusual circumstance. This was due to the fact that on the south section, between Baytown and Hearne, rainfall was of such regularity as to make the soil sticky, which slowed down the ditching machines. On the north end of the line the right-of-way is through considerable rocky terrain. Although the rock is of soft limestone texture, and the trench could be made by the ditching machines without blasting, still the work was considerably retarded. There were several times when each of the two contractors was forced to use as many as three and four ditching machines simultaneously to keep this part of the job ahead of the pipe gangs.

For construction purposes the project was divided into two sections, one contractor laying the section from Baytown to Hearne, the other from that point to Dallas.

Throughout the aim was to provide the pipe with as adequate protection as possible against corrosion. With this in view the entire line was coated and wrapped, being given not the customary single application but a double coating and wrap. This consisted of hot enamel followed by a Fiberglas wrap, then a second coating of hot enamel and an asbestos felt wrap. The Fiberglas wrap embeds itself in the enamel and by thus serving as a reinforcement makes it possible to add the second coating. Total thickness of the enamel on the Humble line is 5/32 in.

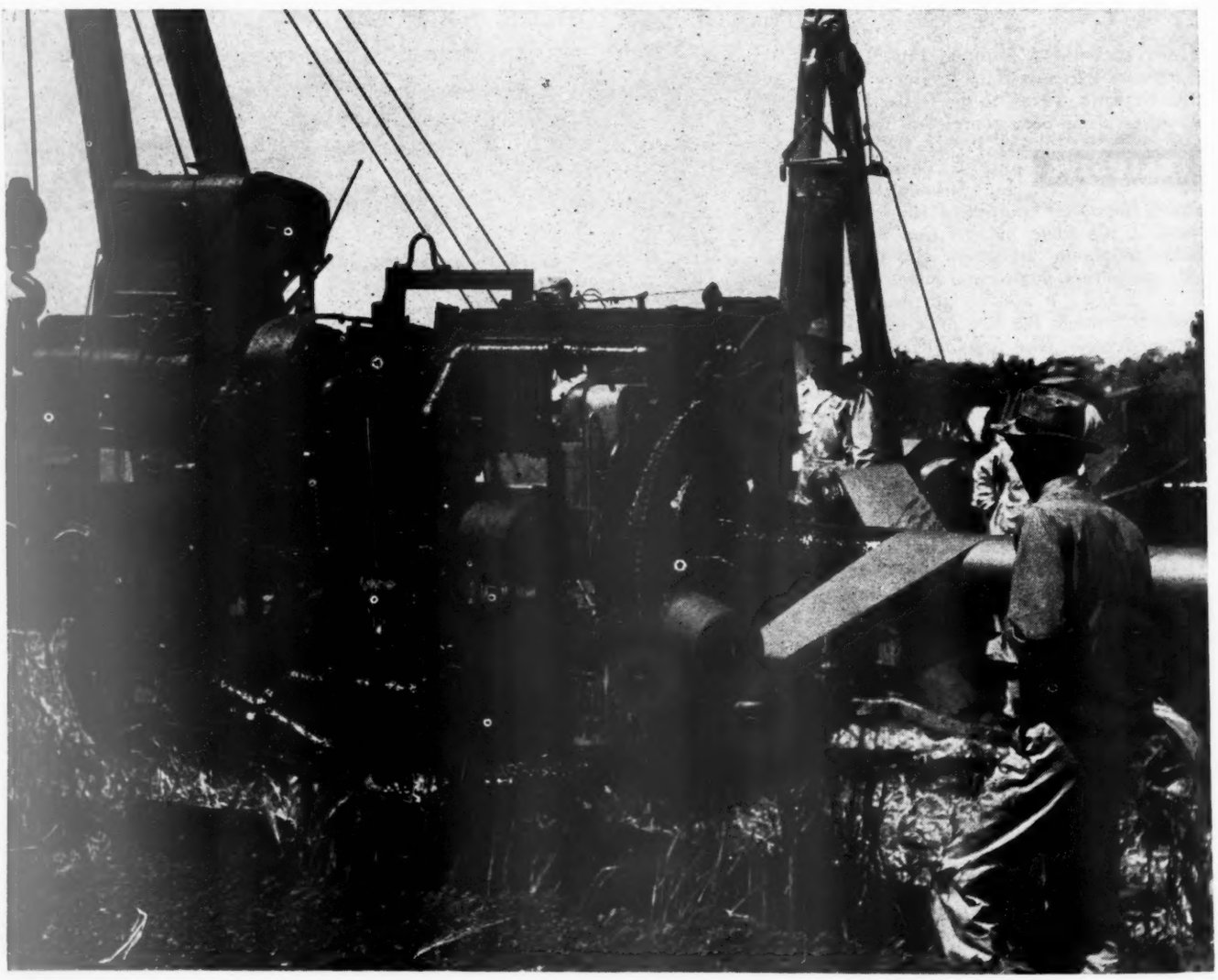
Two methods of applying the coatings were employed. On the south section this was done in a central yard, where the bare pipe, in a continuous series of operations, was cleaned, primed, coated and wrapped by stationary machines, and stacked for hauling to the right-of-way. On the north section, the application was by a traveling-type machine equipped with two coating and wrapping heads, the pipe first having been cleaned and primed.

As another phase of pipe protection, preparations were made for the eventual installation of cathodic protection units. As the line was laid insulating flanges were installed at pump stations and terminals, and on both sides of the interurban tracks between Waco and Dallas, to take care of stray currents. Care was also taken to keep the new line from coming in contact with older pipe lines and other metallic structures, as well as from contact with casings required under highway and railroad crossings. Cathodic protection will be provided when it is deemed advisable and will be not only for protection of the line pipe but for protection of station and terminal tankage as well.

Every effort was made, also, to keep the pipe dry inside to prevent internal corrosion. Each joint was delivered with a protector cap over the ends. The caps were removed immediately before the joints were welded. Further, scrapers propelled by compressed air were run through sections not exceeding 2½ miles in length at the time welds were tested for pinholes. This was to remove foreign matter and debris.

● **River Crossings.** Three rivers were crossed, the San Jacinto, Trinity, and Navasota, the last named being little wider than a good sized creek at the point crossed. The Trinity was crossed three times. All river crossings consisted of single 8-in. lines with sleeves welded over each joint for reinforcing.

Closeup of special machine equipped with two heads, which gave the pipe a double coating and wrapping in one operation. Enamel was applied to a thickness of 5/32 in.



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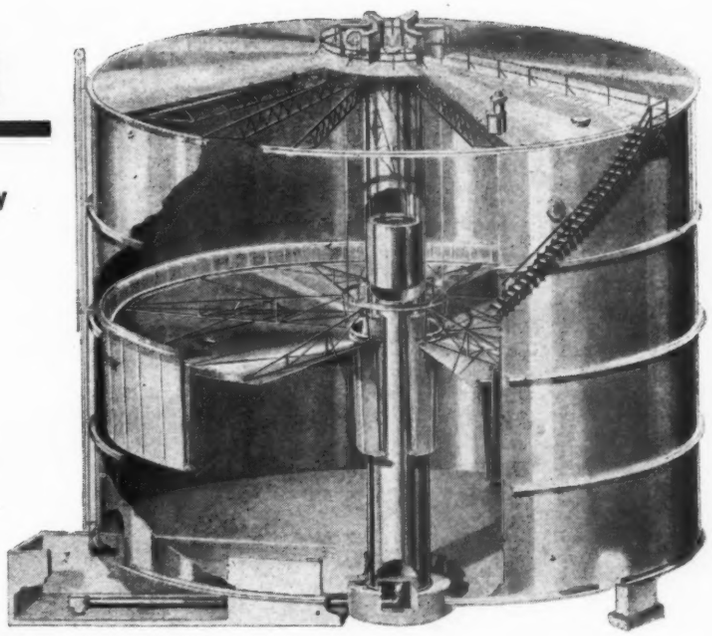

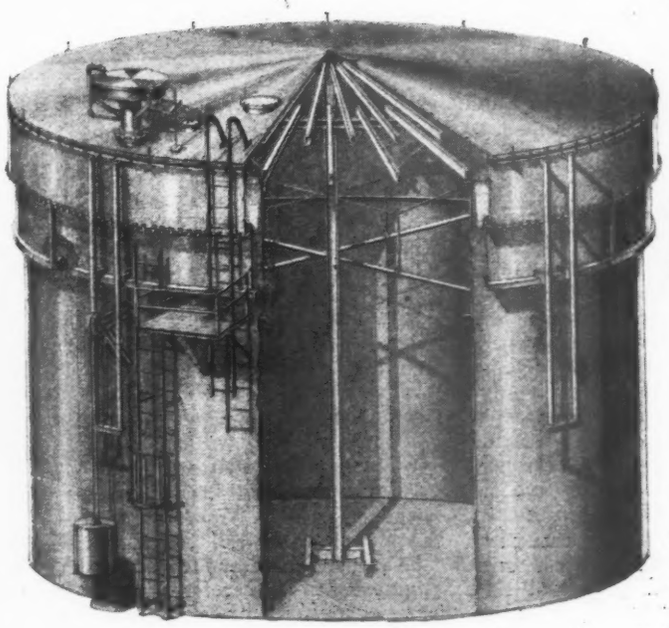

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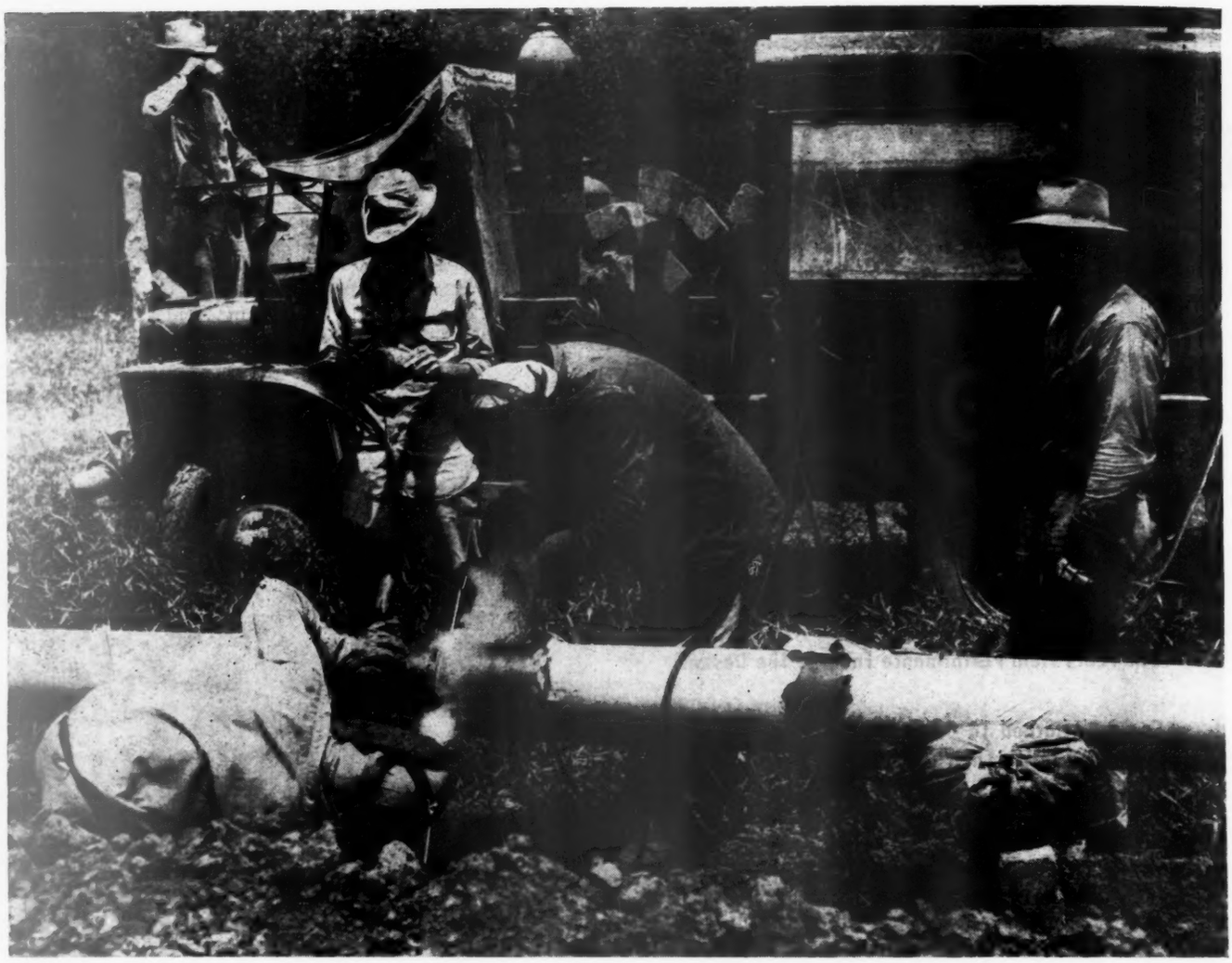


The line was laid of Grade B seamless pipe that came from the mills in double random lengths of 42 to 48 ft., weighing 28.55 lb. per linear ft. The joints were electric welded, as shown here.

No river clamps were used. The water width of the San Jacinto crossing was about 450 ft. A channel was dredged in which to bury the pipe and the pipe section made up and pulled into place. The three Trinity River crossings were each approximately 160 ft. wide, and procedure was the same as in the case of the San Jacinto River.

River crossing pipe was given the same type coating as the rest of the line. Each crossing was tested with water pressure of 1500 lb. per sq. in., the water then being removed from the pipe by the running of two scrapers.

● **Line testing.** As the line was laid a soapsuds test was made of the welded joints, in sections not exceeding 2½ miles in length. After the ends of the line were closed air pressure of 100 lb. per sq. in. was applied to the pipe.

Final testing involved the application of 1500 lb. per sq. in. pressure after filling the line with gasoline. At the time the pipe was laid block gates were welded into the line approximately every ten miles. On each side of the gates a connection was provided for attachment of a portable testing unit to pump the gasoline out of one section of line into the next, in this manner building up the required test pressure of 1500 lb.

● **Pumping stations.** Initial pumping will be with 10-in. stroke gasoline-engine-driven piston pumps, which will give a line capacity of approximately 15,000 bbl. a day into Hearne and about 7,000 bbl. into Dallas. This is temporary pumping equipment and it is expected that permanent units will be available for installation early in 1947. When permanent equipment is installed line capacity will be about 17,000 bbl. a day.

Specifications for the permanent pumping equipment call for three units at Baytown. These will consist of 400-hp. explosion-proof motors operating at 3600 r.p.m. and driving centrifugal pumps. The units will be designed to operate singly or two in series and when used in series will have an operating pressure of 1100 lb. per sq. in.

A booster pump will be provided on each tank suction line to discharge into the main pumping units to provide a positive head on the suction of the latter. The booster pumps will be vertical type single-stage centrifugal units, which is something new for this service. They will be driven by 40-hp. motors.

Operation of the stations will be principally from the control room, the focal point of which will be a control desk similar to those used in stations of the War Emergency Pipelines and Plantation Pipe Line to provide automatically essential data on the pumping units.

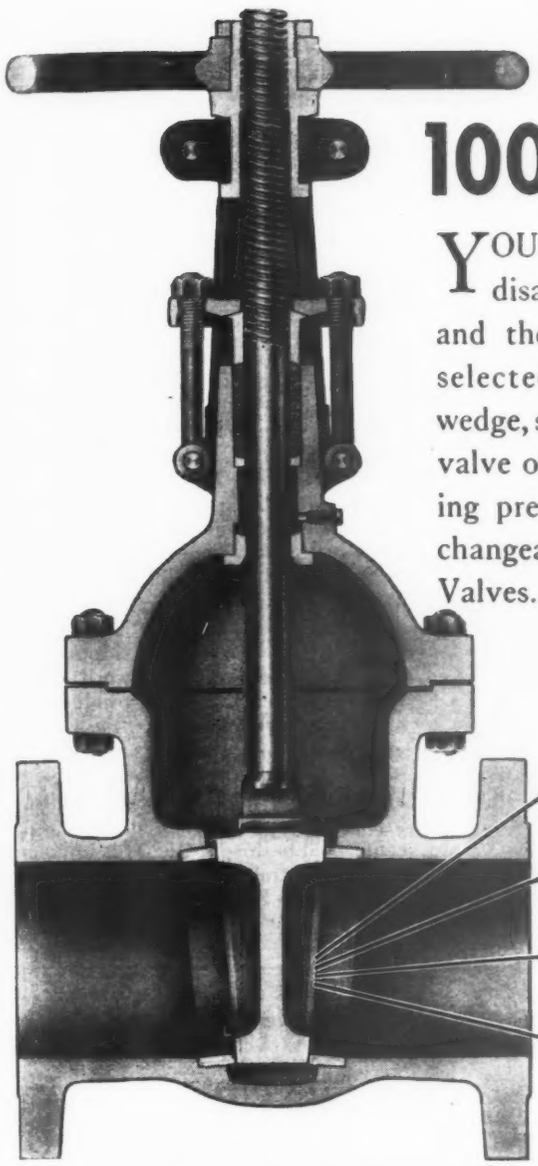
Pumping units at Hearne station will be of the same type and rating as those at Baytown. There will be, however, only two units at this station.

Pumphouses will have a pressure and vacuum system. Pressure of about 2 inches of water will be maintained in the control room and a vacuum in the pump room. If, therefore, any explosive gases should be present, it will be impossible for them to enter the control room.

Positive displacement meters will measure products out of the tankage at Baytown, into and out of tanks at Hearne, and into tanks only at all other points. A calibration tank will be a part of the equipment at each terminal and station to check the meters for accuracy.

Tankage to be provided at the terminals and stations will be as follows:

Baytown station: Two 40,000-bbl. tanks, one 80,000-bbl. tank with cone



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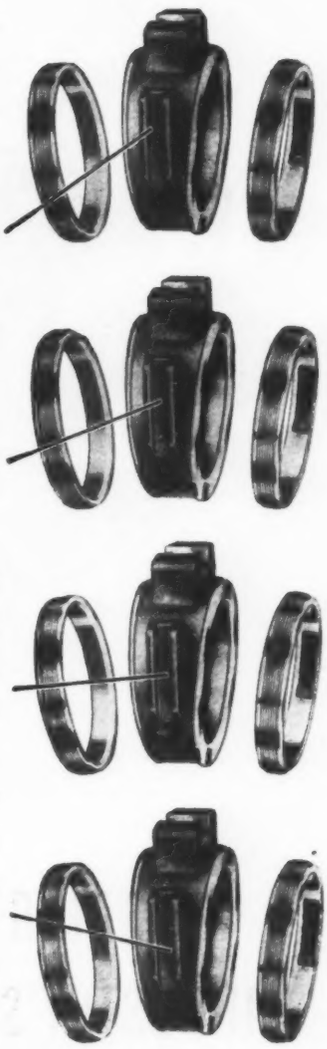

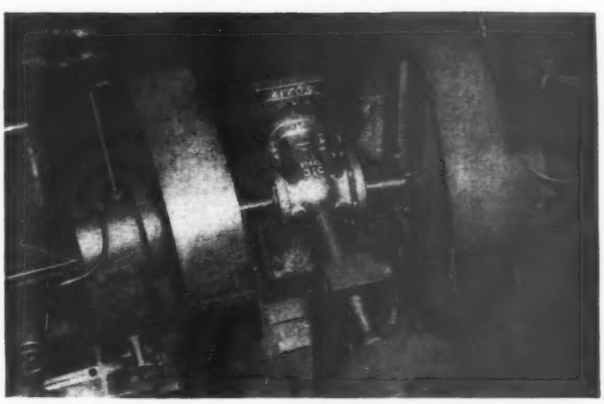

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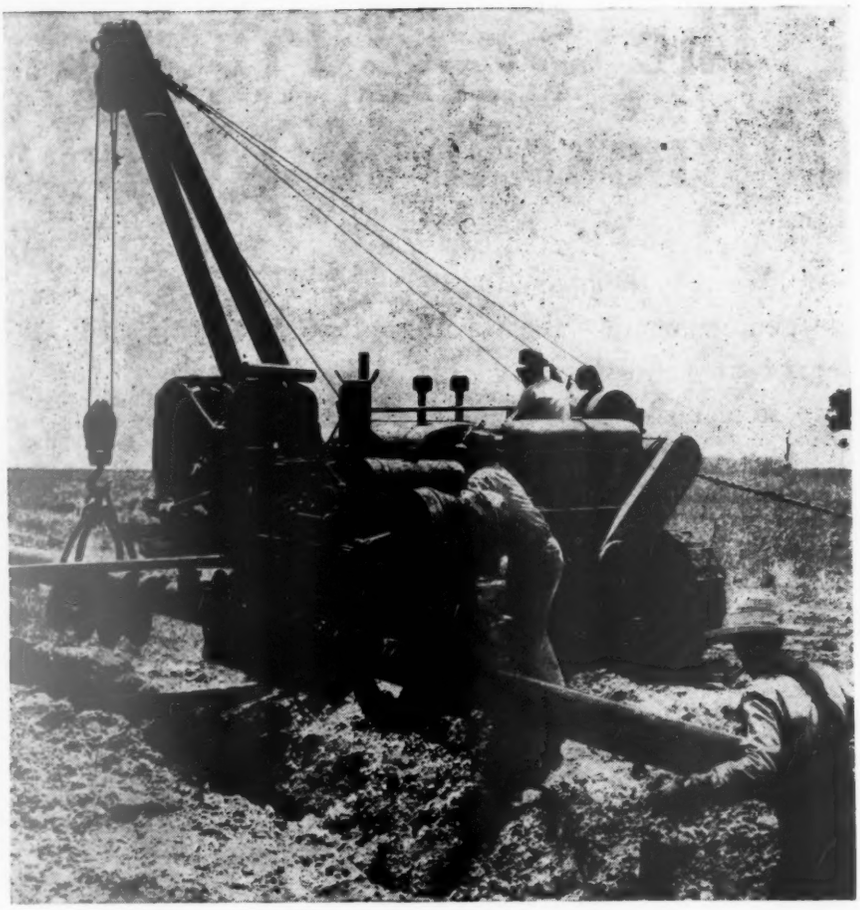

Prior to coating and wrapping the line, the pipe was cleaned and primed by a traveling-type machine.

roof, and one 80,000-bbl. tank with lifter roof.

Houston terminal: One 10,000-bbl. tank, two 30,000-bbl. cone roof tanks, and one 30,000-bbl. tank with lifter roof.

Hearne station and terminal: Two 30,000-bbl. cone roof tanks, and one 55,000-bbl. tank with lifter roof.

Waco terminal: One 24,000-bbl. cone roof tank, and one of the same capacity having a lifter roof.

Dallas terminal: Three 30,000-bbl. cone roof tanks, and one 55,000-bbl. lifter roof tank.

The Sales Department of Humble Oil and Refining Company will own and operate the terminals and storage facilities at Baytown, Houston, Hearne, Waco, and Dallas.

● **Products shipped.** Initially three grades of gasoline will be shipped from Humble's refinery at Baytown. Ultimately it is planned that other products also may be transported by the line.

● **Contractors.** Construction of the section from Baytown to Hearne was by the France Construction Corporation. Coating of the pipe for this section was subcontracted to Rosson-Richards Company. Smith Contracting Company laid the line between Hearne and Dallas. ★★★

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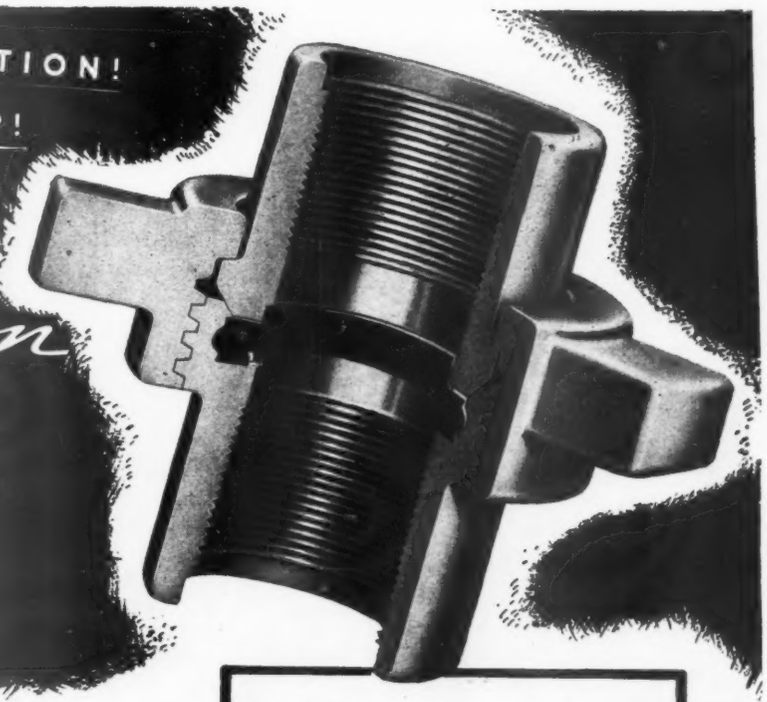

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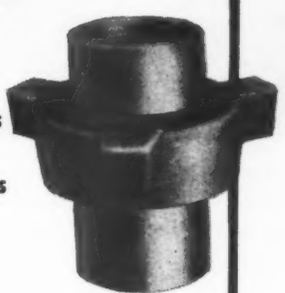
- ★ Water Lines
- ★ Steam Lines
- ★ Cementing Equipment
- ★ Acidizing Equipment
- ★ Gasoline Plants
- ★ Refineries
- ★ Chemical Plants



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SEAL-O-MATIC UNIONS are made in 2", 2½", 3" and 4" sizes with standard 3-lug wing nut. Also made in blanking plug type for use on Christmas Trees, etc. Unions can be ordered with hubs bored for welding to pipe for use in refineries, chemical plants, etc. Available soon, sizes 1", 1¼", and 1½" with hexagon nut. All unions are available with or without SEAL-O-MATIC RING.

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Branch Offices in Oklahoma City, Okla.; Longview, Texas; Kilgore, Texas; Houston, Texas; Alice, Texas; Odessa, Texas; Wichita Falls, Texas; Lafayette, La.; Newark, Ohio.

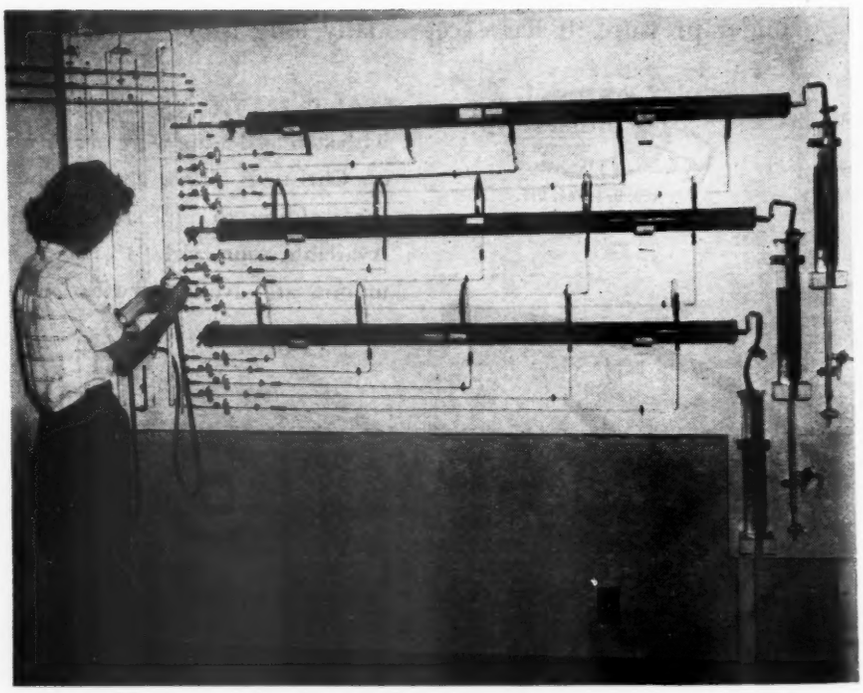
Walter Felt operates a device used to study effects of liner perforation on mud deposition at the face of a producing formation.

W. E. Helmick and W. T. Lietz examine this apparatus for gas analysis, which will be an important feature in the study of injection and other conditions.

Laboratory for production problems

By **RICHARD SNEDDON,** *Pacific Coast Editor*

So vast in its scope has become the petroleum business in its entirety, and so extensive has been the accumulation of scientific data in each specific phase of operation, that it is **EXCLUSIVE** no longer logical to attempt to control in a single institution the diversity of researches that are now carried on daily by a large oil company. The petroleum industry has reached that stage in its development at which specialization is inescapable. Every operation, from the first step in the discovery processes to the last step in manufacture has been explored so fully in a scientific way, that it would seem as though there were nothing further left to do. But it is a peculiarity of scientific advance, that the more progress we make, the more territory we expose for further exploration and exploitation. Thus, past successes, instead of



Device used to determine effect of rate of displacement on oil recovery efficiency.

Jean Taylor conducts a porosity test on a core sample.

On this apparatus she determines the permeability of a core.

bringing us nearer to the end of the petroleum adventure, have merely given us a bigger and better conception of the endless vista that stretches out before us.

Evidence of these facts is to be found in the new-type laboratories that are continuously branching out from the original stem—the research and development department. Not so long ago, one such institution housed all the scientific investigations and experimentations of even a major organization quite comfortably. Now, however, departmental researches have grown so robustly that they themselves must be departmentalized and subdivided into a multitude of activities, each carried on by a chemist, physicist, engineer, or other technician, trained specifically in a particular and appropriate branch of science. The original parent research and development laboratory is now the key structure, through which the efforts of the many subsidiary laboratories are guided, directed, and aided to their most effective accomplishment.

An interesting example of this modernized method of operation is Shell Oil Company's recently completed production laboratory, which occupies a large part of the street floor in the company building on Sixth Street in Los Angeles. This unit is designed and equipped for the special study of production methods, and is under the immediate direction of W. Tempelaar Lietz, senior exploitation engineer, with Walter E. Helmick, senior exploitation engineer, in charge of pressure, volume, temperature, and thermodynamic investigations, and John I. Gates, exploitation engineer, supervising core analyses, and the chemical aspects of production engineering. These gentlemen will be aided by a corps of chemists and physicists, and such other technicians as are required to carry on a pretentious program of research and routine testing. The work of this laboratory will be correlated with that of the company's research groups at Emeryville, California, and Houston, Texas, and in conjuction with these will study the factors involved in production practices, perticularly as they apply in local fields.

The basic function of this laboratory

Pat Holleran operates an apparatus used to detect presence of mercaptan in well gases. The mercaptan is injected in one well and adjacent wells show presence if formation is continuous.

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is to aid the general industry recovery program by every scientific means. Discovery in California is becoming more and more costly, and it is well within the bounds of possibility that the search for new fields may eventually be entirely too burdensome. It is thus highly necessary in the meantime to so adjust and contrive production methods as to assure the maximum ultimate yield. The production laboratory, then, will seek by continuous study the most economic system of raising oil from available sources, and will endeavor to determine how best to recover that so far irrecoverable portion of the oil that remains in the reservoir, when present methods of production have reached the limit of economical operation.

Shell Oil Company's new unit will be especially devoted to experimentation in secondary recovery, and to an intense study of all related principles and phenomena. It will carry on investigations of bottom-hole conditions, determining and weighting in the analytical scheme, such matters as permeability and porosity of producing sands; gas and oil concentrations; flow characteristics of various types of oil in various media; influence of a diversity of factors on oil migration, and an endless succession of similarly pertinent facts and factors.

Changing reservoir conditions in active fields, and prevailing underground conditions in inactive fields, will be further checked by thermo-dynamic examinations, which will yield highly important information relative to gas occlusion, and solution in oil, and volumetric differences occasioned thereby. Specific data with regard to the adaptability of producing formations to gas injection will be derived in many ways, an interesting example being the injection of mercaptan in a selected well, followed by Podbelniak analysis of gas samples from adjacent wells to determine where there is continuity of formation.

The program includes researches on mud usage, and all the multitudinous influences and effects involved. It incorporate the laboratory simulation of many well conditions on a miniature scale, in order to permit actual observation of what might be expected to go on underground. Formation logging, experimental and actual, will be a daily activity, and indeed nothing in the wide gamut of scientific process and devise will be overlooked in this concentrated effort to improve the highly important operations with which it is concerned.

The apparatus for thermo-dynamic investigations, and much of the other special equipment used in this work, was developed by Shell's own technicians, and built in company shops. The entire laboratory has been laid out with its sub-departments in such relationship as to facilitate sequential operations to the greatest extent. For the safety and comfort of the workers, adequate ventilation and air conditioning have been major requirements. An automatic gas detector checks the atmosphere every 40 seconds, and signals in no uncertain manner immediately the concentration of gas reaches even as much as 50 per cent of the combustible limit. In every respect this laboratory is evidence of the fact that we are now entering an era of scientific specialization in the petroleum industry—of which we are going to receive much more evidence from now on.

★★★

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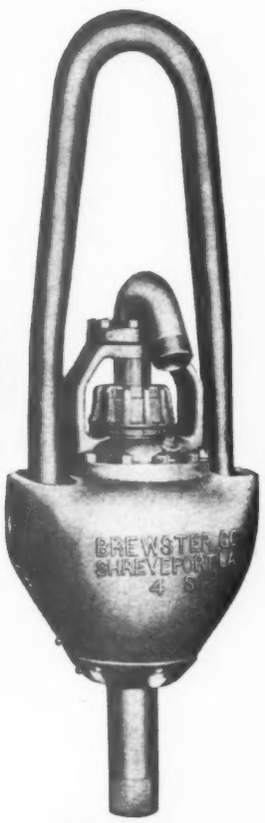

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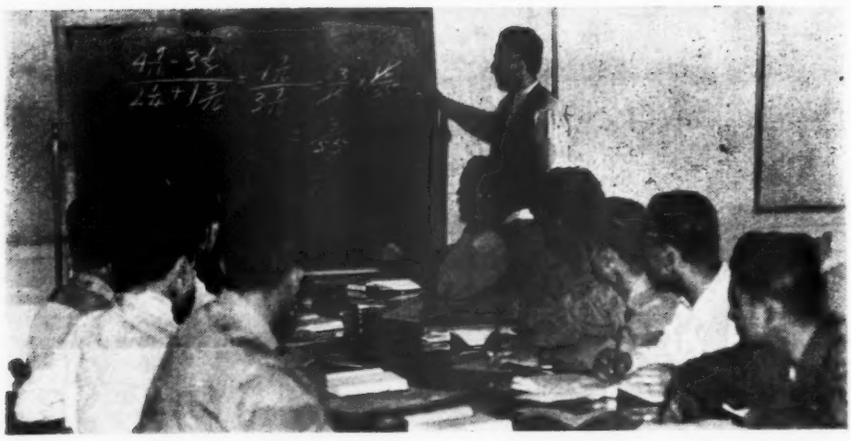


Apprentices study related science.

Veterans on-the-job training program

By **ERNESTINE ADAMS,** *Associate Editor*

SOME 1,700,000 veterans are eligible for on-the-job training under the G.I. Bill of Rights. To date only one out of about 23 has availed himself of the opportunity to learn a trade while receiving an subsistence allowance from the government.

EXCLUSIVE

Industry, including both management and labor, has shown some reluctance to enter this new veterans' training plan except in cases where an apprentice program was already set up. This attitude results from diverse causes, the most common being the aversion to the idea of more red tape on the part of management and the fear of competition from "bargain" employes on the part of unions.

Companies and unions that have established apprentice systems, however, find ample rewards in the practice and readily incorporate the veterans training plan into their own programs.

The oil industry seems to follow the general attitude. Several large companies that already had apprentice courses are taking in veterans for training under the G.I. Bill. Those who have no regular apprentice training programs are apparently apprehensive of complications that may arise from the somewhat vaguely written law.

The G.I. Bill allows subsistence payments of as much as $65 a month for single veterans and $90 for those with dependents. An amendment to the bill passed in August provides "that in no event shall the rate of such allowance plus the compensation received from the government exceed $175 per month for a veteran without dependents or $200 per month for a veteran with dependents."

The training period may be from three months to two years, depending upon the veteran's time in service and the trade to be learned. The administrator may use his judgment in training periods shorter or longer than those stated.

The veteran is given time in which to become skilled in his trade without making financial sacrifices during the period required to learn it. The company pays the regular basic wage for unskilled labor, to which the government adds as much as $65 or $90 a month to bring the total to journeyman's wages or close to that amount. Thus the veteran is not penalized by the years he spent in the service when he might have been learning a trade.

The company supplies supervising instruction, including classes to a total of 144 hours a year, and any training aids and materials necessary; it also keeps record of hours, earnings, and progress of the trainee.

In return the industry has a wider choice and superior quality of employes because of the greater than usual compensation. It is assured of trained workers in the future although there is no stipulation that the veteran must be retained by the firm after the course is completed. Most responsible companies enter the program with the idea of training men and women for future employment with its own plants or offices because of the advantage of having skilled workers whose capabilities are known to the management. The idea, however, of gaining experience in plants other than the one where apprenticeship was taken is still popular in some management and employe quarters.

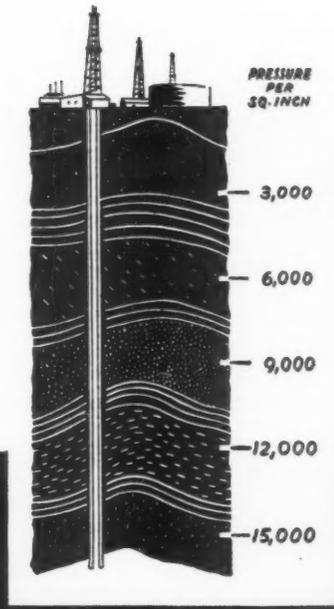
The regulations by which a company becomes qualified to employ veterans under the G.I. Bill and the rules by which a veteran becomes eligible for apprentice training are simple and can be followed without consuming a great deal of time.

Steps for Employer

1. Select the job classifications in your plant in which veterans can be efficiently trained. Usually management makes a survey to determine future demand for skilled workers in each classification before including it in the apprenticeship lists.* All skilled workmen must have years of training back of them and it is too late to wait until they are needed to start training them.

*One company uses the following outline to estimate number of apprentices needed in various departments:

1. Determining the number of present employes in the department who will have retired in the next few years.
2. Considering the turn-over in the department and arriving at a figure for replacements.
3. Considering the sickness and death rate and arriving at a figure of loss to these causes.
4. Estimating the manpower needs for the next few years based on the normal expansion curve of the craft. For instance, if the number of machinists in the refinery has increased year by year, future manpower needs should be based on this.
5. Estimating the needs through future expansion.



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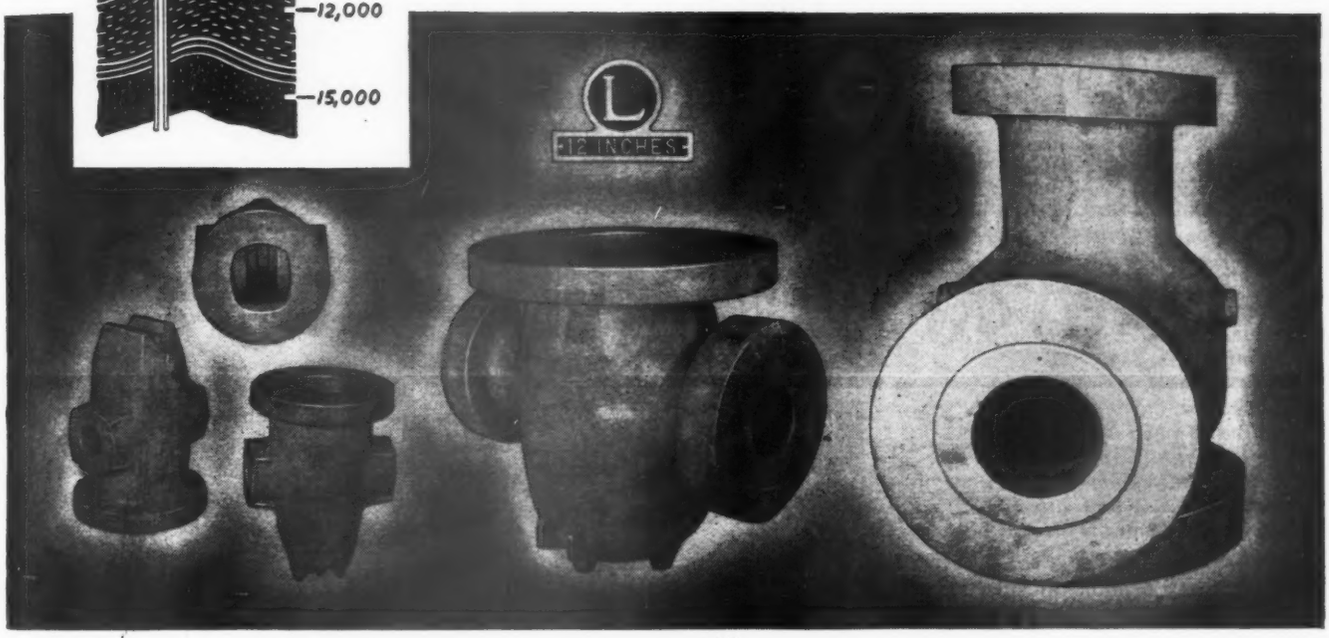

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The soundness and integrity of Circle Ⓛ 205A1 high-strength alloy steel castings and their outstanding physical properties are derived not alone from their chemical analysis but very largely from the extra heat treatment which they received in Lebanon's scientifically controlled furnaces.

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Minimum Physical Properties — Normalized and Drawn	
Tensile Strength . . . 100,000 lbs.	Elongation in 2" . . 17%
Yield Point 65,000	Reduction of Area . 30%
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2. Make an outline of the program to be followed. This should include:

b. *Length of time required for training.*
b. *Method of choosing apprentices.*
c. *Rates of payment at beginning and approximate time and amount of wage raises.*
d. *Method of program administration.*
e. *Type of instruction to be given.*

3. Write to state head of Educational and Training Institutions under 346, 78th Congress (G.I. Bill) applying for certification of any one or more of the company's plants for employment of veterans for on-the-job training. This letter must contain the following information:

a. *Location of plant(s).*
b. *Outline of training program proposed, including title and description of job objectives and length of training period and number of hours of supplemental instructions required.*
c. *Monthly salary to be paid trainee (if hourly rates are paid, multiply 176 by regular hourly rate of pay) at beginning of training period, at each successive step in the program, and at the completion of training.*
d. *Monthly salary paid qualified operator in job for which veteran is training.*
e. *Cost of tools, equipment, and supplies that the trainee will be required to possess.*
f. *Agreement to supply to the Veterans Administration monthly a statement showing the attendance or work record and the amount paid to trainee during month.*

4. Upon certification by the state committee apprentices are selected from those sent by the Veterans Administration, through regular employment channels, or from among veterans already employed by the company. Basis for selection include:

a. *Medical examination.*
b. *Intelligence tests.*
c. *Mechanical aptitude tests.*
d. *Other tests useful for determining aptitude in specific jobs.*

These tests can be given by the Veterans Administration.

5. When veteran is employed the company reports at once to apprentice committee, giving name of veteran and enclosing copy of eligibility letter.

Steps for Approving Agency

In the August amendment to the G.I. Bill the state agency or administrator may approve the application of an employer for training upon the following conditions:

1. The training content of the program is adequate to qualify the veteran for appointment to the job for which he is to be trained.

2. There is reasonable certainty that the job for which the veteran is to be trained will be available to him at the end of the training period.

3. The job is one in which progression and appointment to the next higher classification are based upon skills learned through organized training on the job and not on such factors as length of service and normal turnover.

4. The wages to be paid the veteran for each successive period of training are not less than those customarily paid in the establishment and the community to a learner in the same job who is not a veteran and the wages are in conformity with State and Federal laws and applicable bargaining agreements.

5. The job customarily requires a period of training of not less than three months and not more than two years of full-time training.

6. The length of the training period is no longer than that customarily required by the establishment and other establishments in the community to provide the trainee with the required skills, arrange for the acquiring of job knowledge, technical information, and other

FIG. 1. An apprentice signs an agreement along the lines of this one with his employer when he begins his training period.

NATIONAL JOINT APPRENTICESHIP AND TRAINING COMMITTEE
FOR THE ELECTRICAL INDUSTRY
(Address)

APPRENTICESHIP AGREEMENT

THIS AGREEMENT, entered into this.....day of....., 19...., between the parties to.....
Name of Electrical Apprenticeship Standards
represented by the Joint Apprenticeship Committee, hereinafter referred to as the COMMITTEE and....., hereinafter referred to as the
Name of Apprentice
APPRENTICE (and if a minor).....
Name of Parent (or Guardian)
hereinafter referred to as his Guardian.

WITNESSETH THAT:

WHEREAS, in order to preserve and perpetuate the skills essential to true craftsmanship and to maintain the ranks of skilled mechanics in the electrical industry; and

WHEREAS, the above named Electrical Apprenticeship Standards have been developed in conformity with the National Electrical Apprenticeship Standards which have been registered with the Federal Committee on Apprenticeship, Apprentice-Training Service; and

WHEREAS, the APPRENTICE through his parent (or Guardian) has expressed a desire to enter the required period of apprenticeship subject to the aforementioned Standards,

NOW, THEREFORE, in consideration of the premises and the mutual covenants herein contained the parties hereto do hereby agree as follows:

THAT, the Committee shall provide employment and training to the APPRENTICE in accordance with the Standards herein referred to

THAT, the APPRENTICE shall perform diligently and faithfully the work of said trade during the period of apprenticeship, in conformity with the aforementioned Standards and in accordance with the rules and regulations of the said Joint Apprenticeship Committee.

THAT, the GUARDIAN will make all reasonable efforts to assure proper and diligent performance by the APPRENTICE of all obligations assumed under this agreement.

The Electrical Standards referred to herein is hereby incorporated in and made a part of this agreement.

In witness whereof the parties hereunto set their hands and seals:

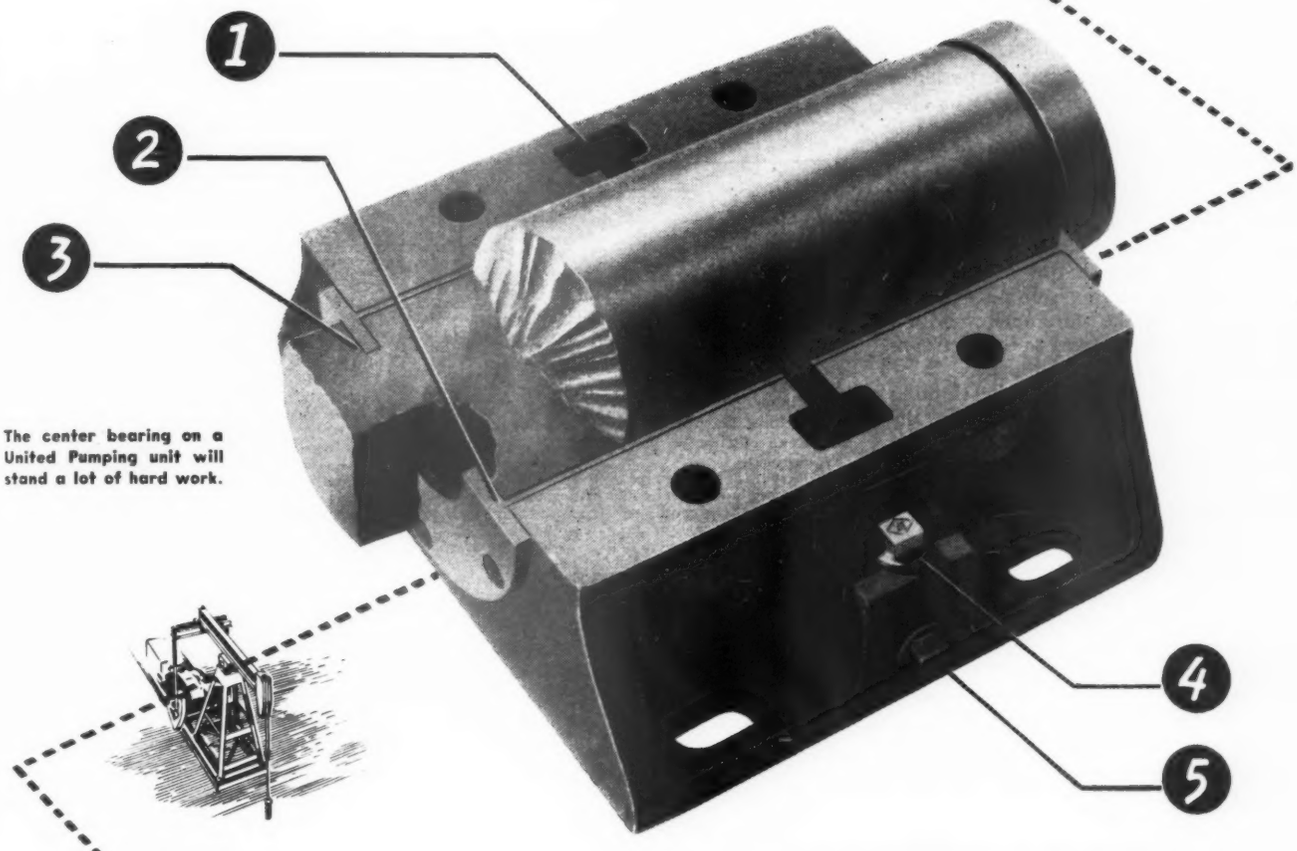
.....(SEAL)	.....(SEAL)
Apprentice	Representative of Joint Apprenticeship Committee
.....	.....
Address	Title
.....(SEAL)	.....(SEAL)
Parent (or Guardian)	Representative of Joint Apprenticeship Committee
	.....
	Title

Registered by the.....
by..... Title..... Date....., 19....

The undersigned agrees to provide employment and training in accordance with Standards named herein.

1st	2nd .....
Employer	Employer
3rd	4th .....
Employer	Employer

NO EVERYDAY OILING CHORES



The center bearing on a United Pumping unit will stand a lot of hard work.

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United's Superior Lubrication System Includes:

1. **OIL RESERVOIR** with sufficient capacity to maintain operation over long, unattended periods.
2. **LEAKPROOF OIL SEAL** flange on the main bearing to hold the oil in and dust and sand out.
3. **STEEL BEARING SHAFT**, heat-treated and machined to close tolerance.
4. **OIL INTAKE** easily accessible for checking and filling.
5. **OIL DRAIN** conveniently located to allow lubricating from a safe position.

With the enclosed oil bath system of lubrication, United Units reduce daily maintenance time. United's lubrication system requires no seal or packing yet is positively leakproof. The oil bath holds sufficient lubricant for long periods of operation. The United Unit is equipped with D. O. James Continuous-Tooth Herringbone Gears, insuring long life and dependability. For a Pumping Unit with a record of low-maintenance cost — and trouble-free operation — look to United.

UNITED SUPPLY AND *Manufacturing* COMPANY

TULSA, OKLAHOMA

Stores in Kansas, Oklahoma, Texas, Louisiana and New Mexico

facts which the trainee will need to learn in order to become competent on the job for which he is being trained.

7. Provision is made for related instruction for the individual veteran who may need it.

8. There is in the establishment adequate space, equipment, instructional material, and instructor personnel to provide satisfactory training on the job.

9. Adequate records are kept to show the progress made by the veteran toward his job objective and a periodic report showing the conduct and progress made in the course of training on the job will be provided for the Veterans Administration.

10. Appropriate credit is given the veteran for previous job experience, whether in the military service or elsewhere, his beginning wage adjusted to the level to which such credit advances him and his training period shortened accordingly. No course of training will be considered bona fide if given to a veteran who is already qualified by training and experience for the job objective.

11. A copy of the training program as approved by the state agency is provided to the veteran and to the Veterans Administration by the employer.

12. Upon completion of the training the veteran is given a certificate by the employer indicating the length and type of training provided and that the veteran has completed the course of training on the job satisfactorily.

FIG. 2. Apprentice monthly work record. The time is placed under the letter that represents the type or types of work performed during the day.

NAME EMP. NO. MONTH OF 19

DEPT. SHIFT HOURLY WAGE RATE

DATE	HOURS WORKED ON EACH TYPE OF OPERATION																TOTAL	RATINGS			FOREMAN
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P		WK	SP	AT	
1																					
2																					
3																					
4																					
5																					
6																					
7																					
28																					
29																					
30																					
31																					
TOT.																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P					

REMARKS

DATE TIME CLERK

APPRENTICE MONTHLY WORK RECORD

LEGEND—

A. Drill press (single and radial)
B. Shaper
C. Planer
D. Milling machine (vertical & horizontal)
E. Gear cutting
F. Sprocket
G. Lathe (bench, turret and engine)
H. Boring mill (vertical and horizontal)
I. Grinder (internal, external and surface)
General machine repair, dismantling, assembling of:
J. Compressors
K. Centrifugal pumps
L. Reciprocating pumps
M. Other machinery, internal combustion engines and miscellaneous outside work
N. Layout, toolwork, jigs, tools, dies, gages, bench and floor work
O. Heat treating (all branches)
P. Classroom

Steps for Veteran

1. Veteran first applies at the nearest VA where he will have a screening interview and discuss with a counselor the prospects in the industry or industries in which he is interested. This may be in office work as well as in the trades.

2. He will be given an application blank to fill out for a course of training or retraining. The form includes all pertinent information about the veteran's background, education, and service record but it is neither long nor complicated. A photostatic copy of his discharge or separation papers must accompany form when it is filed.

3. Aptitude tests may be given in the VA office to the veteran who wants direction in his choice of a trade or business.

4. If the applicant is qualified he is given a "letter of eligibility" by the VA to present to his employer or prospective employer.

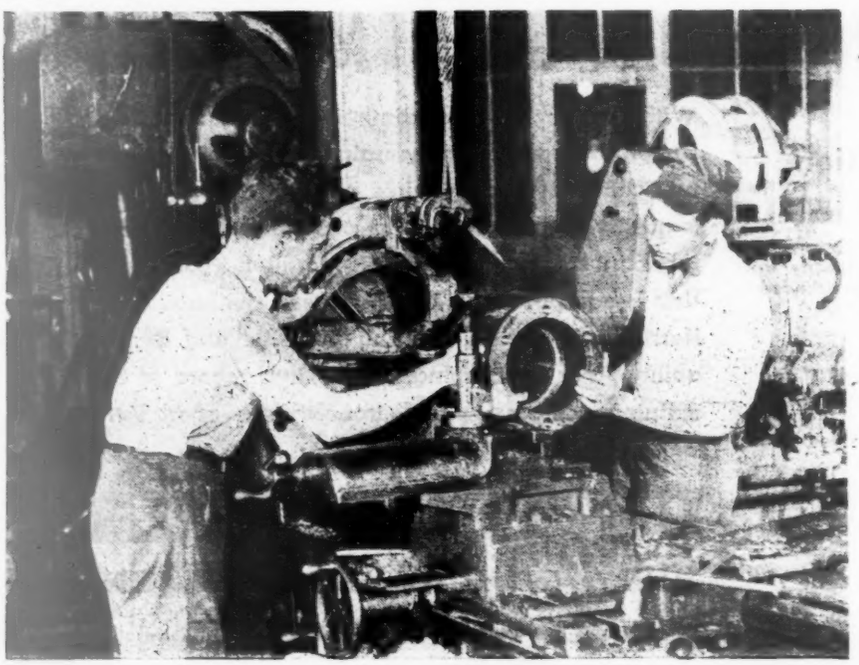
5. The veteran is then directed to an employer who is listed with the VA or the United States Employment Bureau. He may already have made contact with the employer and been accepted for apprenticeship before making application for subsistence payments with the VA.

6. Some companies have apprentice agreements stating clearly the length of the apprenticeship, the standards to be reached, the conditions and terms upon which the veteran begins training. This agreement is sometimes entered into jointly by the company and the union.

From this point where the employer and veteran have come to an agreement, the veteran's duties are simple and direct: report for work regularly and learn the trade or business. The employer must direct the work and the education from this point on but there is no complicated red tape in the procedure.

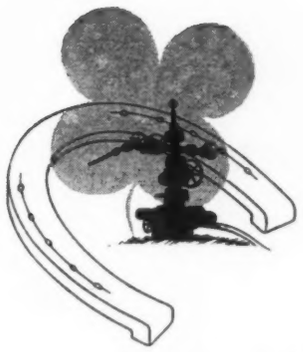
The company must have records of the apprentice. This includes the agreement signed by the applicant, a monthly work (and class) record, and a master

Apprentice machinist set up for lathe operations.

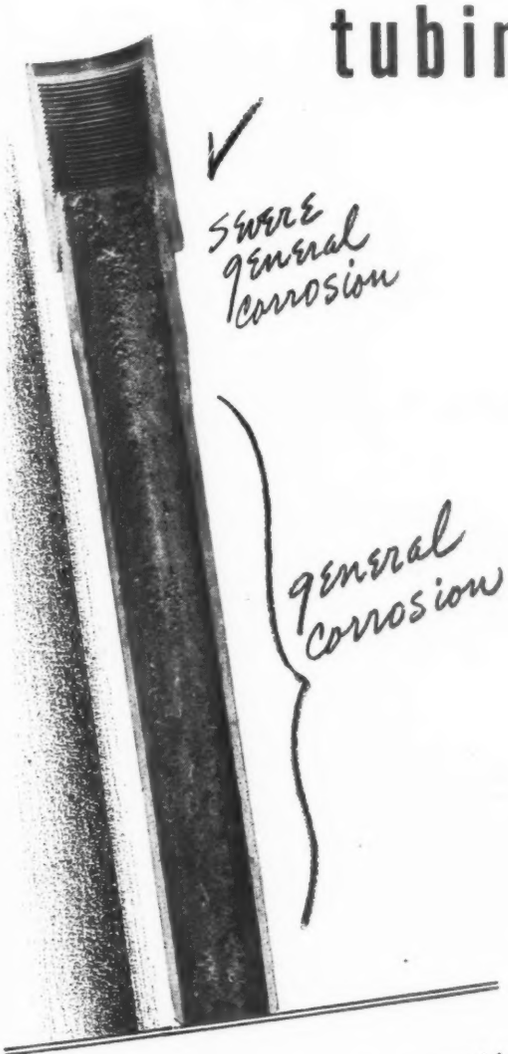


PHOTOS BY COURTESY OF STANDARD OIL COMPANY OF NEW JERSEY

are you operating a string of tubing



on a string of luck?



This section of corroded tubing, when compared by visual inspection to the metal chart used in the Otis Tubing Caliper, proved the Caliper to be accurate in every detail in detecting the extent and depth of the corroded areas.

an OTIS TUBING CORROSION SURVEY

An Otis Tubing Corrosion Survey, made with the Otis Tubing Caliper, gives you an accurate (to within .01 inch) inside story of tubing corrosion. Generally accepted by the industry as a quick and economical method of detecting the extent and depth of penetration of corrosion, the Otis Tubing Caliper has already proved that the tubing in numerous wells—located in areas where corrosion was suspected but not believed to be serious—was either completely penetrated or corroded to the extent that further operations would be hazardous. Likewise, in some instances where corrosion was detected in one well, another well on the same lease and producing from the same formation showed no corrosion.

The Otis Tubing Caliper is run and pulled under pressure on a steel measuring line by experienced Otis crews. It operates on a mechanical, direct-contact principle—six spring-loaded feeler arms are pressed against the tubing wall and connected to a stylus which records their movement on a metal chart as they "feel out" corroded areas. After the Caliper has been run, the metal charts are photostated and each joint of tubing and tubing coupling is individually analyzed and graded as to the extent of corrosion. These photostats and tabulations, along with a comprehensive discussion of the condition of the tubing, are delivered to the well operator within a few days.

Don't run out your string of luck! Write Otis Pressure Control, Inc., 6612 Denton Drive, Dallas, Texas, *now*, about an Otis Tubing Corrosion Survey. An Otis representative will be glad to contact you upon request.

OTIS T. M. REG.

OTIS PRESSURE CONTROL, INC.
TUBING CALIPER

C-2

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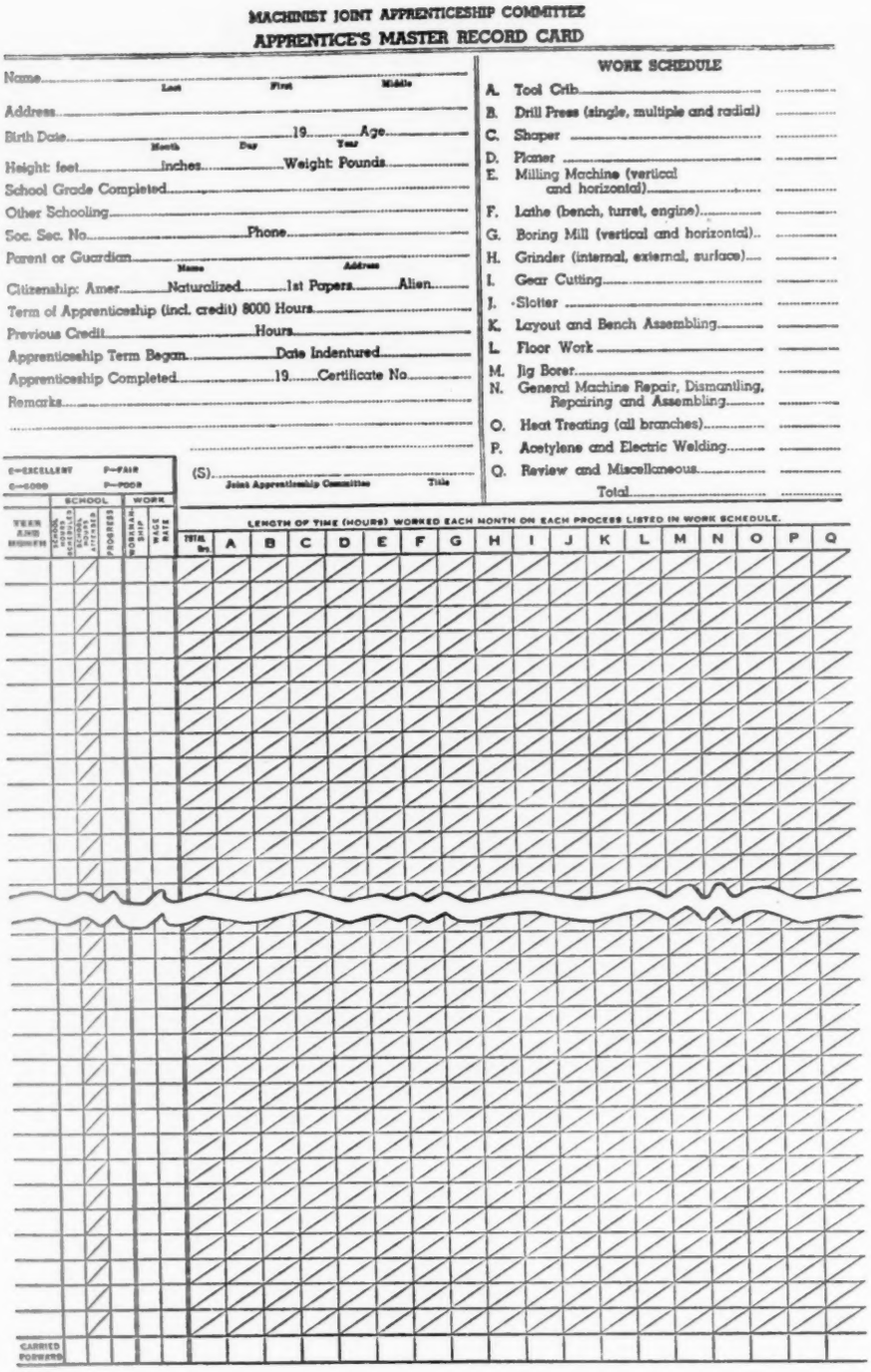
OTIS ENGINEERING CORPORATION—MANUFACTURE AND DEVELOPMENT
DISTRIBUTORS: OTIS PRESSURE CONTROL, INC., DALLAS, TEX.; OTIS EASTERN SERVICE, INC., BOLIVAR, N. Y.; WESTERN PRESSURE CONTROL, LOS ANGELES, CALIF.



MACHINIST JOINT APPRENTICESHIP COMMITTEE

APPRENTICE'S MASTER RECORD CARD

Name ..... Last ..... First ..... Middle

Address .....

Birth Date ..... Month ..... Day ..... 19 ..... Year ..... Age .....

Height: feet ..... Inches ..... Weight: Pounds .....

School Grade Completed .....

Other Schooling .....

Soc. Sec. No. ..... Phone .....

Parent or Guardian ..... Name ..... Address .....

Citizenship: Amer. ..... Naturalized ..... 1st Papers ..... Alien .....

Term of Apprenticeship (incl. credit) 8000 Hours .....

Previous Credit ..... Hours .....

Apprenticeship Term Began ..... Date Indentured .....

Apprenticeship Completed ..... 19 ..... Certificate No. .....

Remarks .....

WORK SCHEDULE

A. Tool Crib .....
B. Drill Press (single, multiple and radial) .....
C. Shaper .....
D. Planer .....
E. Milling Machine (vertical and horizontal) .....
F. Lathe (bench, turret, engine) .....
G. Boring Mill (vertical and horizontal) .....
H. Grinder (internal, external, surface) .....
I. Gear Cutting .....
J. Slotter .....
K. Layout and Bench Assembling .....
L. Floor Work .....
M. Jig Borer .....
N. General Machine Repair, Dismantling, Repairing and Assembling .....
O. Heat Treating (all branches) .....
P. Acetylene and Electric Welding .....
Q. Review and Miscellaneous .....
Total .....

E—EXCELLENT G—GOOD F—FAIR P—POOR

(S) ..... Joint Apprenticeship Committee ..... Title

SCHOOL | WORK

YEAR AND NUMBER | SCHOOL HOURS | SCHOOL GRADES | SCHOOL PROGRESS | WORK PROGRESS | WORKMANSHIP | WAGE RATE

LENGTH OF TIME (HOURS) WORKED EACH MONTH ON EACH PROCESS LISTED IN WORK SCHEDULE.

TOTAL Hrs. | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q

CARRIED FORWARD

FIG. 3. A master record (actual width 8½.) indicates the progress of each trainee during his entire period of apprenticeship.

record card on which total hours and progress are kept. A certificate of completion of apprenticeship should be given the employe who has finished the course.

The company must also have an instructor to acquaint the new apprentice with the personnel and with layout of his surroundings. The apprentice is expected to receive 4 hours a week or 144 hours a year of classwork to advance his training. This is an integral part of the regular Department of Labor apprentice program and those who have set up on-the-job training have already provided for special instruction. With veterans' training this phase has not been stressed because small firms may have only one or two trainees. Some employers are providing instruction through local schools, allowing the veteran to take time from his duties to attend classes pertinent to his work and providing any tuition required.

The monthly report of the company to the VA is simply a statement of the work record (the number of hours on the job) and the amount the veteran was paid for his services.

If the veteran received $135 from the company and the job he was training for paid $200, he would get $65 a month from the government if he had dependents, $40 if he had none. The employer pays more, the government less as the training period progresses until the employer pays the entire salary at the end of the training.

In the oil industry the companies that have undertaken the training program for veterans have been pleased with results so far. On the whole these firms had already established indentured apprenticeship training and had only to submit an outline of the program to receive approval from the committee so that apprentices who were veterans could receive the subsistence allowance and get aid in the purchase of tools from the government.

In an apprentice program of one company 45 per cent of the 95 apprentices in a southern refinery are veterans and eligible for G.I. payments. These apprentices are being trained for meter and instrument men, machinists, tinners, and electricians.

Another company, which has also had standard four-year indenture apprentice training courses for years, now has 58 apprentices in one refinery, all of whom are veterans. They are training as pipefitters, insulators, machinists, electricians, welders, boilermakers, tinners, tank car repairmen, carpenters, painters, blacksmiths, and bricklayers.

Still a third company has a total of 60 apprentices enrolled in on-the-job training of whom 44 are veterans, eligible for subsistence payments.

All of these companies employ instructors for four hours a week during which schooling is given in subjects related to their work, such as mathematics, blueprint reading, shop theory, office management, bookkeeping, sketching, etc.

This is a propitious time for smaller organizations to launch worthwhile schedules. Although large companies that have analyzed their apprenticeship program costs have stated that the plan more than paid for itself.** There will be even less risk with the government paying part of the trainee's wages and helping with the purchase of tools.

Small drilling contractors, seismograph crews, service organizations, small refiners, and other of the multitude of small businesses that go to make up the oil industry can now begin as comprehensive a training program as the larger companies. Experienced workmen can give practical instruction on the job. Classes can be arranged with local schools or the apprentices can be entered in the numerous short courses that are offered by colleges in cooperation with the oil industry.

The importance of speedy training in all industry has grown as the techniques and methods of operation have become more complicated, as equipment and machinery have grown more intricate. Employers have found there is great advantage in hiring skilled labor trained in their own or similar plants.

**"Evaluating Apprentices" by O. L. Harvey, Senior Technical Analyst, Apprentice-Training Service. Booklet will be sent upon request to Department of Labor, Washington, D. C.

★★★

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Chain Belt Company	Rotary Chain
J. T. Crenkhite	Crenkhite Valves
Dean Brothers Pumps, Inc.	Pumps
Hewitt Rubber Corp.	Rotary Hose
Hughes Tool Company	Rock Bits, Valves, Tool Joints
S. M. Jones Company	Sucker Rods
Kennedy Valve Mfg. Co.	Valves, Fittings
Ladish Drop Forge Company	Forged Steel Flanges
Larkin Packer Company	Floating Equipment
A. Leschen & Sons Rope Co.	Drilling Lines
Lunkenheimer Company	Valves, Steam Specialties
Nordstrom Valve Division, Rockwell Mfg. Co.	Plug Valves
Oil Center Tool Company	Heads, Christmas Trees
Pittsburgh Steel Company	Seamless Casing, Drill Pipe
Rector Well Equipment Co.	Heads, Christmas Trees
Reed Roller Bit Company	Rock Bits, Valves, Tool Joints
Republic Steel Corp.	Casing, Tubing, Line Pipe
St. Louis Cordage Mills	Manila Rope, Cordage
Tube Turns, Inc.	Tube Turns, Welding Fittings, Flanges
Unit Rig Company	Drilling Rigs
Victaulic Company of America	Couplings

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Effects and corrections of gas pulsation problems

By **FOSTER M. STEPHENS**
Principal Research Engineer
Development Department
The Fluor Corporation, Ltd.

THERE are many secondary effects of pulsative gas flow that are usually more easily recognized than the original source itself. One of these is vibration, which is often objectionable in gas compression plants, refineries, gasoline plants, cycling plants, or in most cases where gas, air, or steam is being compressed. There seems to be no pressure ranges from vacuum to 5000 lb. per sq. in. that are free in all instances from line and equipment vibrations. Many factors enter into the degree of pipe vibration, such as type of supports, spacing, and whether the system is overhead or on the ground. It likewise has been observed that expansion loops and general piping arrangements may be contributors to excessive vibrational displacements.

Unfortunately, for the sake of pipe and equipment, excessive accelerations, which are a function and measure of vibrational stresses, can often be measured where the piping is securely fastened and there is a minimum of visibile shaking present. This has particularly been noticed in some cases where expansion loops are placed horizontally and securely clamped. In many instances the results of the continuous acceleration stresses results in shearing of the bolts in the pipe clamps or shattering of the concrete pipe supports. Usually compressor discharge lines are worse offenders than compressor suction lines as far as mechanical vibration is concerned. There are of course exceptions to this, which may be caused by mechanical or acoustical resonance in the suction system.

Aside from vibrational effects, pulsative flow is a chief contributor to inaccurate orifice metering, resulting in errors in excess of 20 per cent in some instances. Phenomenal cases have even been reported in which the meter showed the gas to be flowing in a reverse direction from the actual flow. These metering errors are often experienced regardless of whether the meter run is placed on the suction or the discharge side of the compressor. Remote locations of metering stations from the compressor station does not always solve the metering problem, for there are many times when the pulsative flow is known to be present in the gas stream many miles from the compressor station.

Pressure gauge readings fall into the same pressure fluctuating disturbances as meters and there are many instances when it is almost impossible to get an accurate pressure reading in the proximity of a compressor station due to the gauge responding to the pressure pulsations.

Horsepower loss due to pulsative flow represents an exceedingly complicated story when considered from all angles. On the discharge side, high instantaneous pressures may be produced in compressor cylinders because of discharge line pulsations. This often occurs when several compressors are operating in tandem and discharging into a common header. Likewise, reflections can be produced from pipe bends, valves, or other abrupt changes in gas flow conditions. The result of this type reflection is again that of high instantaneous peaks.

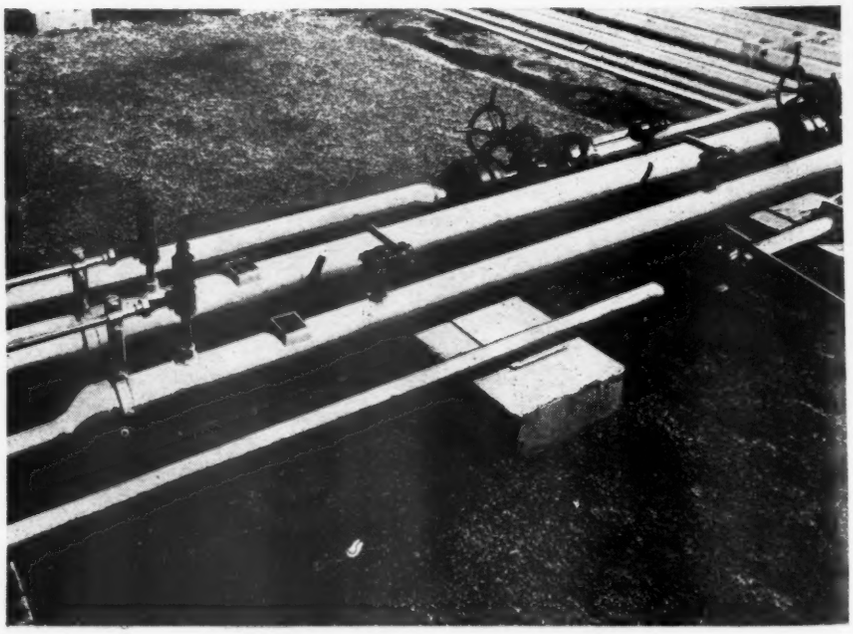
Another horsepower loss is the extra pressure drop required to drive a pulsative flow through a transmission line. Due to the high instantaneous velocities achieved at the pulse peak, the pipe frictional effect is in excess of what would be encountered for a steady flow.

On the suction side of the compressor pulsations can create cylinder starvation at one instant and a supercharged condition the next instant. We have observed cases where engine speed hunting was so bad that it was impossible to operate all engines at the same time.

There naturally have been corrections applied to many of the previously described problems as they appeared in the field, resulting at least in partial solutions to the problem. Many of these corrections have been by trial and error and therefore do not represent a universal solution.

In the case of pipe vibrations, various arrangements of piping have been tried and, although it is beyond the scope of this article, it may be said in general that some are decidedly better than others in this respect. The usual procedure when excessive vibration displacements are observed has been to tie down the points of excessive displacements structurally. There have been occasions when this resulted in a shift of the point of maximum displacement to some other part of the piping system, thereby creating the necessity for additional structural supports. In many instances it has been necessary to repeat this procedure several times before the entire problem was corrected. In this connection it should be pointed out that it is virtually impossible to predict and space piping supports in such a manner as to be non-resonant to

Pulsation dampeners installed on 4000-lb. and 1500-lb. high pressure discharge headers at a major oil company's cycling plant.



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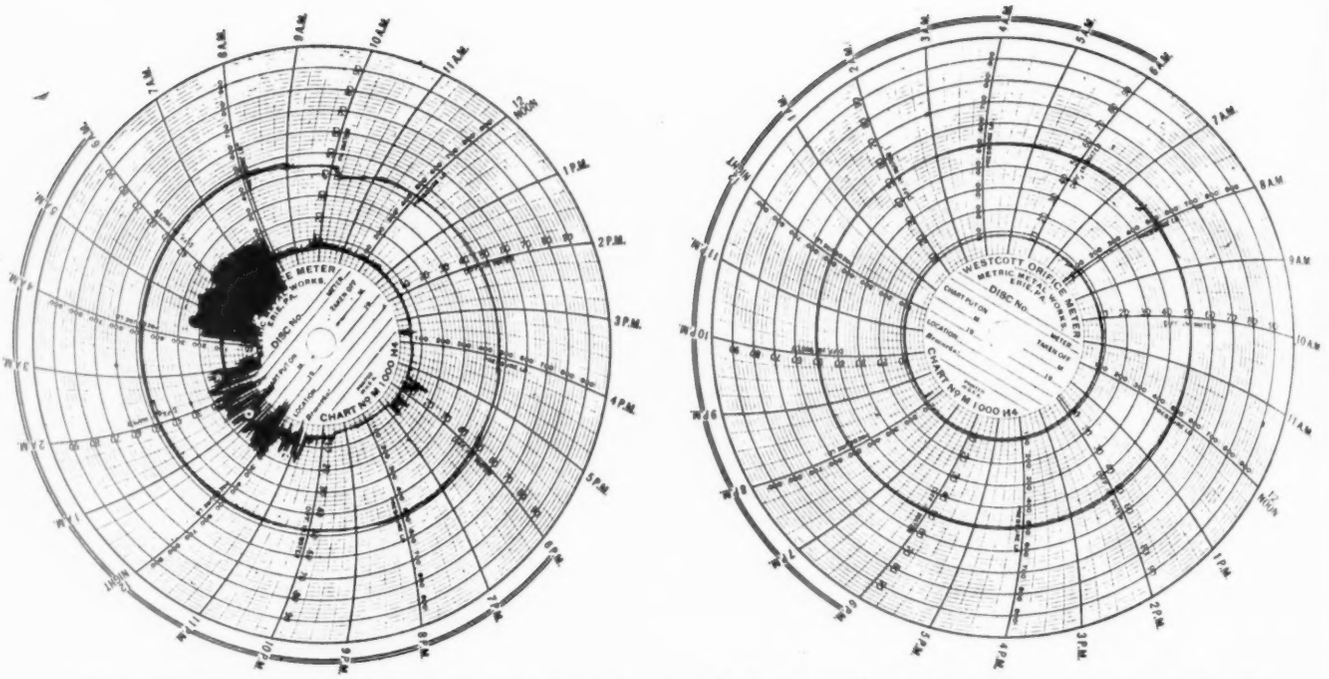


Orifice meter chart, left, made by a large western gas company before installing pulsation dampeners. Vibration due to pulsative flow has, in some cases, caused orifice meter readings to be as much as 100 per cent off. Right, orifice meter chart made by the same company after installing pulsation dampeners. (Recording line visible just under the "10").

all the varying frequencies and beat frequencies of pulsation that may result from several compressors running at varying speeds and discharging into a common header. For a single compressor running at fairly constant speed, however, there are certain predictable pipe spans that should be avoided and these can be calculated with a fair degree of accuracy.

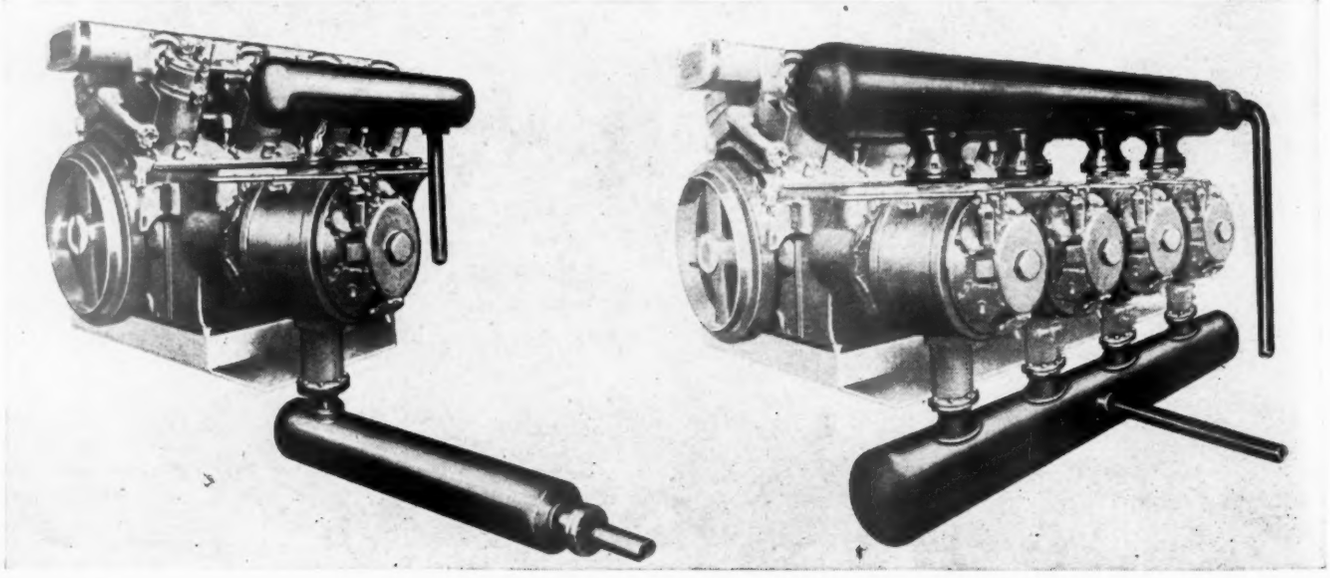
Another method has been utilized in recent years for decreasing the magnitude of piping vibration. It consists of installing mechanical vibrational dampeners at certain strategic spots in the piping system. These mechanical dampeners have been made in various forms. They usually consist of combinations of weights and springs, weights and rubber, or just springs. The principle employed by these devices is that of changing the natural frequency of the vibrating member or of absorbing the vibrational energy by being resonant to the vibrational frequency. The disadvantages of these devices are that usually they are only a partial cure for the trouble, and require exact location and adjustment to be effective.

To keep metering errors at a minimum, many systems have been used. The simplest of these consists of pinching valves in the meter lead lines. In some instances volume chambers and even orifice plates have been installed ahead of meter runs. To summarize these procedures it may be stated that they at least help to procure meter readings that are readable, whereas there are cases that without some type of dampening devices it would be impossible even to read the meter charts.

Volume bottles are quite often installed on both the discharge and suction side of compressors. Their volume

Pulsation dampeners installed on both suction and discharge sides of single-cylinder compressor of the gas engine-driven type.

The dampeners installed on both suction and discharge sides of four gas engine-driven compressor cylinders operating in parallel.



Are your tanks inhaling moisture as they breathe?

Moisture, carried in the air a tank breathes, pollutes the contents of that tank. You can't stop the breathing; air is sucked in as the temperature drops and as the tank is emptied. But you can remove the moisture from the air it's breathing.

Install a LECTROBREATHER at the vent. The tank still breathes freely, but the air passes through Activated Alumina and is dried DRY.

A color indicator on the LECTROBREATHER shows when a healthy charge of moisture has been picked up. Time, then, to lift off and install a spare, drive off the moisture with a Lectrodryer Reactivator, and hold it ready for future use.

Write today for recommendations on DRYing equipment to meet your needs. Pittsburgh Lectrodryer Corporation, 326 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
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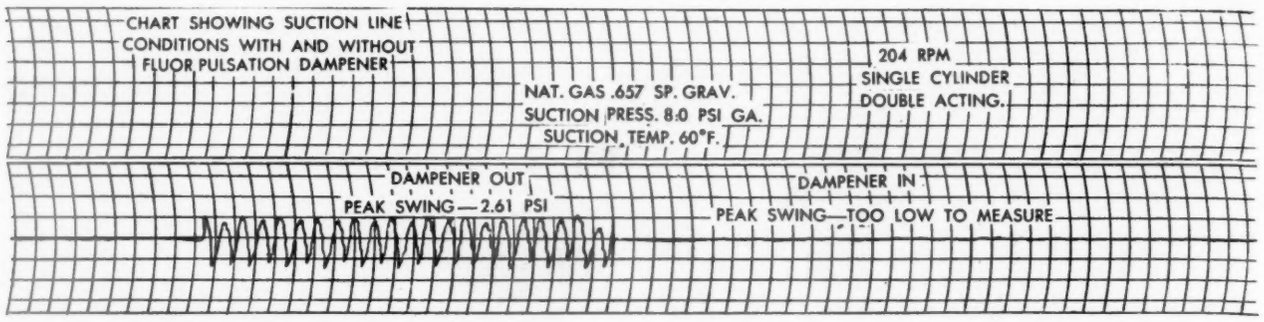
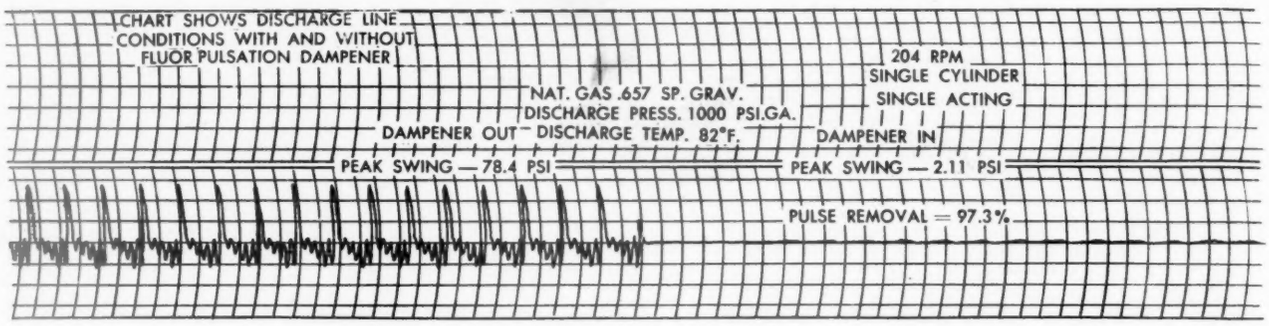


CHART SHOWING SUCTION LINE CONDITIONS WITH AND WITHOUT FLUOR PULSATION DAMPENER
NAT. GAS .657 SP. GRAV.
SUCTION PRESS. 8.0 PSI GA.
SUCTION TEMP. 60°F.
204 RPM
SINGLE CYLINDER
DOUBLE ACTING.
DAMPENER OUT
PEAK SWING — 2.61 PSI
DAMPENER IN
PEAK SWING—TOO LOW TO MEASURE

Charts made from experimental pulsation dampener hookup in Fluor research laboratory pilot plant. (Suction side of compressor above, discharge side of compressor below.)



often varies over quite a range, depending on the pressure and compression ratio involved. In many instances their cubical contents vary from five to fifteen times the compressor displacement. Their purpose is to minimize the effects of reflections previously mentioned and thereby permit the compressor cylinders to work under the most advantageous conditions, and consequently keep horsepower losses at a minimum. In addition to volume bottles the lateral piping is often oversized to add additional volume to the system. Most of these volume bottle installations improve the ill effects of pulsation but in general do not reduce them to a minimum because of the large volumes required to do this. The volume and consequent size required for a satisfactory pulsation reduction in the higher pressure services is extremely uneconomical and is often impracticable to locate. Upon occasions resonate conditions have been produced by bottle and lateral sizes where pulsative conditions were more pronounced than would have existed had no partial corrective measure been applied.

The pulsation dampener, designed on a filter principle, has been universally used to correct pulsation problems and consequently their secondary effects by converting the pulsative flow into a steady flow. The design is sufficiently flexible to allow for either a manifold type for multi-cylinder service, or an in-line type for single cylinder service. Being a filter device it offers only a high resistance to a pulsative flow and permits a steady gas stream to pass through it with very low pressure drop. In most cases, it is practical to design dampeners for a pressure drop of about ½ per cent of the operative pressure, which are capable of removing in excess of 95 per cent of the pulsation peaks. With the elimination of this high percentage of pulsations then it naturally follows that vibration in piping and equipment caused by pulsative flow is eliminated. This means that elaborate hold-down systems, mechanical dampeners, etc., may be eliminated. It also follows that any errors in metering due to pulsations are automatically eliminated by the removal of the pulsations.

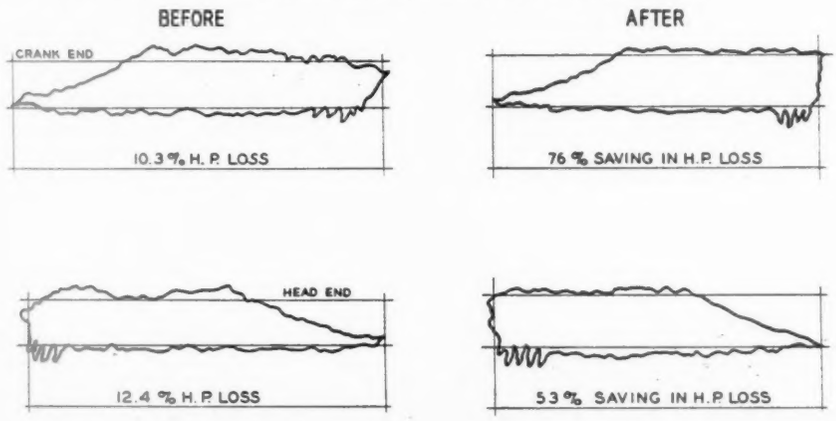
Improvement in compressor cylinder conditions by the installation of pulsation dampeners may be divided into two classes, namely, installation on discharge and installation on suction side.

Installation of dampeners on the discharge side of compressors results in the removal of pulsations on the high pressure laterals, headers, and equipment. The compressor cylinders are naturally working under a more advantageous condition in this instance because there can be no reflections, resonant conditions, or standing waves that can create unusual instantaneous pressure conditions within the cylinder during the interval that the discharge valve is open.

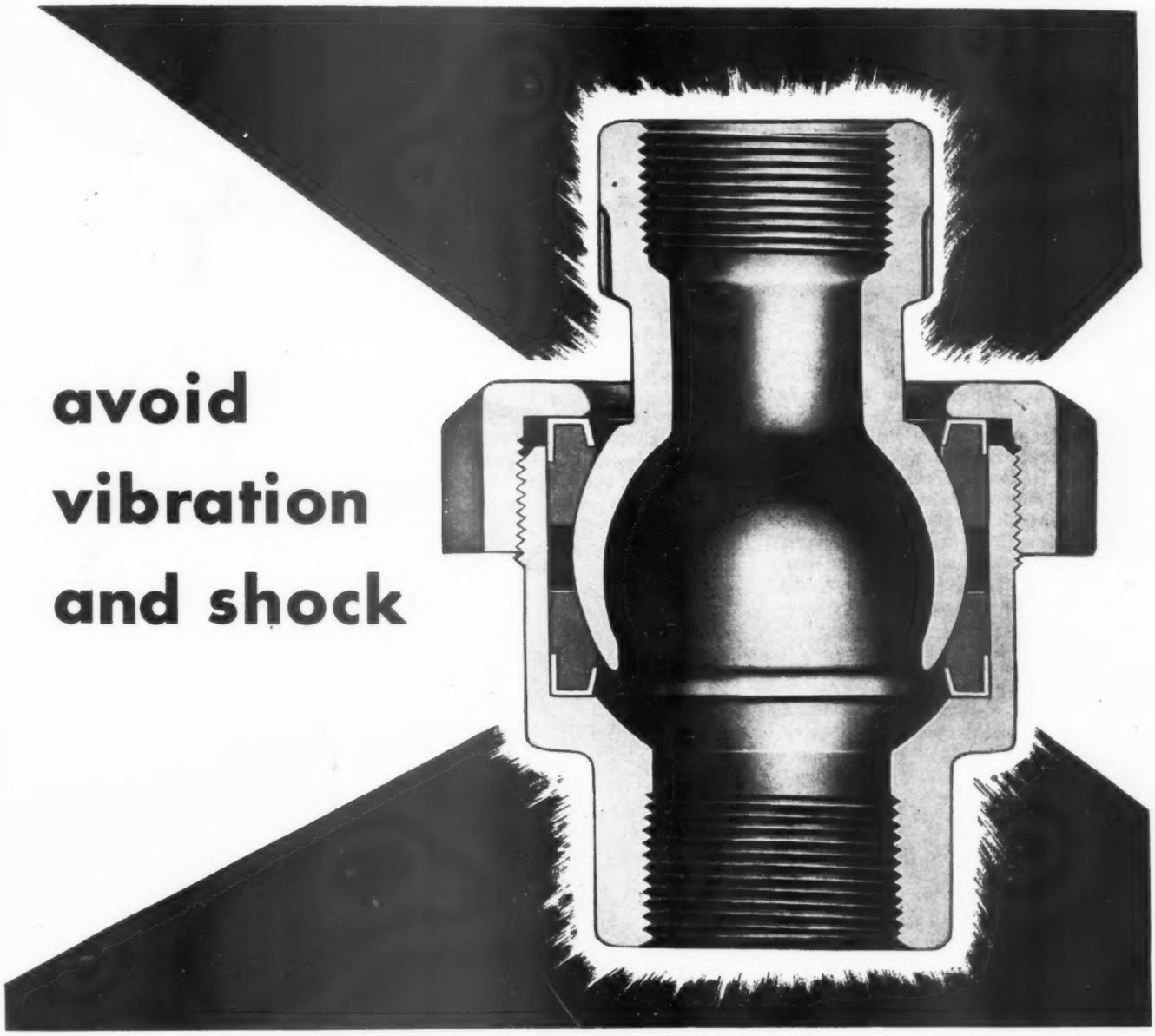
On the suction side of compressors the installation of dampeners results in a uniform pressure condition at the time the suction valve is open. This prevents the previously mentioned condition of starvation one instance and a supercharged condition the next, and results in a uniform suction pressure condition for the compressor.

One other factor in plant design is worthy of mention and that is the fact that all piping and equipment may be sized for steady flow if dampeners are to be installed, thereby eliminating the effect of oversizing for pulse peak velocities. ★★★

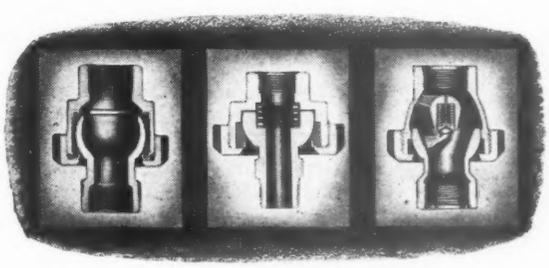
These horsepower indicator cards were made at a large southwestern gas company plant before and after installing pulsation dampeners. Considerable horsepower savings were effected on both the crank and head ends of the compressor after pulsative flow was eliminated.



avoid vibration and shock



There's no such thing as a RATTLING good fluid line!



Flexibility to withstand vibration and shock is indispensable in every fuel line. Barco Flexible Joints assure steady flow of vital industrial fluids by providing responsive movement in fluid conveyors. They compensate for expansion and contraction, absorb the strains of changing pressures and constant vibration. Technical engineering data will be sent on request. Barco Manufacturing Co., Not Inc., **1825** Winnemac Avenue, Chicago 40, Illinois.

BARCO FLEXIBLE JOINTS

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

E ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"

Programs announced for A.I.M.E. petroleum division fall meetings

PETROLEUM engineers from all parts of the country will gather at Galveston, Texas, on October 3, 4, and 5, and at Los Angeles, California, on October 24 and 25, to participate in the fall meetings of the Petroleum Division, AIME.

Program for the meetings has been released by Herbert F. Beardmore, Barnsdall Oil Company, Tulsa, Oklahoma, division chairman. The Galveston meeting at the Galvez Hotel has been designated the official business meeting of the division. The technical program for this meeting, which was arranged by a committee headed by H. H. Kaveler, Phillips Petroleum Company, Bartlesville, Oklahoma, includes presentation of the following papers:

"Evaluation of Pressure-Maintenance by Internal Gas-Injection in Volumetrically Controlled Reservoirs" by E. Charles Patton, Jr., Magnolia Petroleum Company, Dallas, Texas.

"Protecting Oil Storage Tank Bottoms With Magnesium" by J. R. James and R. L. Featherly, The Dow Chemical Company, Midland, Michigan.

"Geothermal Gradients in Mid-Continent and Gulf Coast Oil Fields" by Earl A. Nichols, Core Laboratories, Dallas, Texas.

"A New Method for Measurement of Oil Saturation in Cores" by R. L. Boyer, F. Morgan, and M. Muskat, Gulf Research and Development Corporation, Pittsburgh, Pennsylvania.

H. H. Kaveler, Program Committee Chairman

"Interstitial Water by the Capillary Pressure Method" by O. F. Thornton, The Texas Company, Houston, Texas, and D. L. Marshall, The Texas Company, New Orleans, Louisiana.

"Phase Relations of Hydrocarbon-Water Systems" by Donald L. Katz, University of Michigan, Ann Arbor, and John McKetta, associate professor of chemical engineering, University of Texas, Austin.

"Review of Geophysical Prospecting Devices, Methods and Procedures" by Paul Weaver, Gulf Oil Corporation, Houston, Texas, and C. H. Dresbach, Western Gulf Oil Company, Los Angeles.

"A Study of Some Factors Affecting Gun Perforating," S. C. Oliphant, The Stanolind Oil and Gas Company, Houston, Texas, and R. Floyd Farris, The Stanolind Oil and Gas Company, Tulsa, Oklahoma.

"Engineering Developments in Southwest Texas" by John W. Crutchfield and Horton T. Pruett, consulting petroleum engineers, Corpus Christi, Texas.

"Consolidation of Loose Sands With Plastics" by Ralph Smith and A. C. Polk, Jr., Dowell Incorporated, Houston, Texas.

This paper presents the results of using plastics to reduce caving or production of sand from wells.

"Extending the application of Electric Analogy in Oil Reservoir Studies" by Henry Schaefer, Stanolind Oil and Gas Company, Tulsa, Oklahoma.

"Effective Technical Group Speaking" by A. Ross Rommel, Humble Oil and Refining Company, New Orleans, Louisiana.

"Marine Drilling in Venezuela," by James A. Clark, Creole Petroleum Company, New York.

"The Use of Helium as a Tracer in Oil and Gas Reservoirs," by E. M. Frost, U. S. Bureau of Mines, Amarillo.

The Gulf Coast Section of the AIME with Mercer H. Parks, Humble Oil and Refining Company, Houston, Texas, chairman, is acting as the host section of the Galveston meeting. Arrangements for a reception on October 3, a banquet and dance on October 4, and a fishing trip on October 5 are being planned by a committee of the Gulf Coast Section that is headed by Haylett O'Neill, Humble Oil and Refining Company, Houston, Texas.

The Pacific Petroleum Chapter with William W. Porter, II, Los Angeles, California, as chairman, is acting as host for the division at the Los Angeles meeting, which will be held at the Ambassador Hotel. The technical program was arranged by a committee under the direction of H. C. Pyle, Bank of America, Los Angeles, California, and A. W. Gentry, Long Beach Development Company, Long Beach, California, and will include presentation of the following papers:

H. F. Beardmore, Division Chairman

"Principles of Radioactivity Well Logging," by J. E. Kilkenny, CCMO Company.

"Hydraulic Couplings and Hydraulic Torque Converters," by Nicholas D'Arcy, Chas. W. Carter Company.

"Electronic Oil Pool Analyzers," by Dr. W. A. Bruce, Carter Oil Company.

"Electrolytic Oil Pool Analyzers," by John Sherborne, Union Oil Company.

"Phase Behavior," by Bruce Sage.

"Decrease in Ultimate Recovery Due to Lowering of Productivity Indices," by Vaughn Moyer, Union Oil Company.

"Laboratory Results Concerning Selection of Drilling Fluids for Use With Fine Mesh Liners," John Gates, Shell Oil Company.

"Reservoir Mechanics of D-7 Zone, Ventura Field," by E. V. Watts, General Petroleum Corporation. ★★★

REPUBLIC VALVES REPUBLIC

REGULATING—PRESSURE REDUCING—SHUTOFF

CYLINDER OPERATED

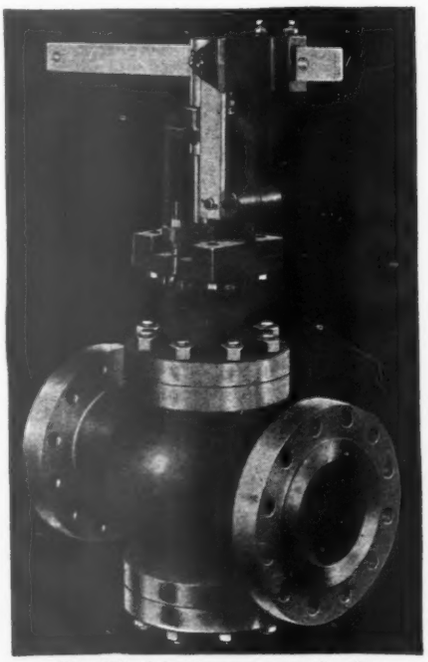
Republic cylinder operated valves are of the gradual opening, high lift, double seated type. They are hydraulicly operated to assure smooth performance at any speed regardless of size, static pressure or pressure reduction. These valves are available in sizes from 3" to 24", with or without hand operating wheel. Due to compact design, a regulator may be mounted directly on the valve.

HAND OPERATED

Republic hand operated valves, in sizes from 1" to 8", are built to 900 lb. and 1500 lb. pressure standards. Sizes up to 2" are also available for 600 lb. pressure. They are of the single seated type, have a one piece valve stem, and seat rings that are Stellite surfaced. On the larger sizes the gear reduction head is built with ball or roller bearings and precision ground gears for minimum friction and back lash.

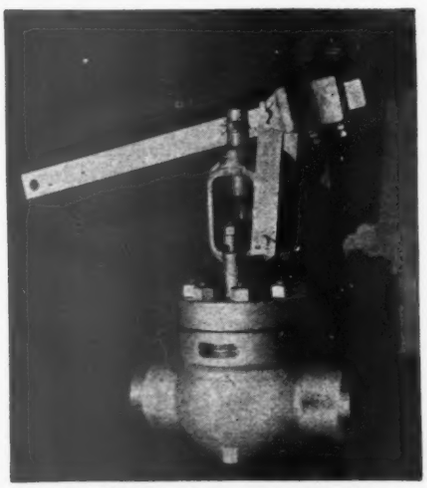
For your key jobs, where valves must not fail—where they must continuously and accurately regulate the pressures and flows of steam and water on which other vital processes depend—Republic valves give you the dependability you need.

Let a Republic Engineer consult with you on your specific pressure and flow regulating problems.



Republic 6 in. lever operated valve

Republic 12 in. cylinder operated valve



Republic 2 in. lever operated valve

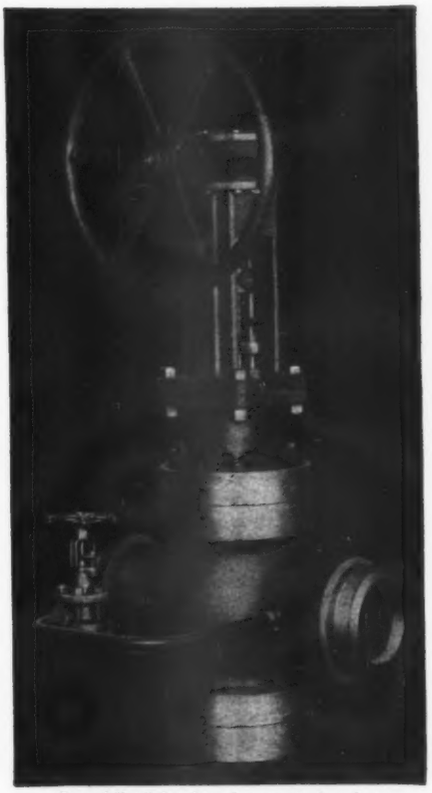
LEVER OPERATED

Republic double seated lever operated valves are available in sizes from 3" to 16" for low pressure applications and in sizes up to 6" for 1500 lb. applications. They are ideal for air actuation with long stroke cylinders. The lever mechanism is of sturdy construction capable of taking full strain of power cylinder.

Single seated lever operated valves are available in sizes up to 2" and for pressure up to 1500 lb. standard. The sturdy lever mechanism is adjustable for lift.

BUTTERFLY VALVES

Republic butterfly valves can be supplied in cast iron or steel for pressures up to 300 lbs. Vanes can be supplied of the angle seating or swing through types. The shaft can be mounted on ball or plain bearings as required. A valve operator may be mounted directly on valves of 6" size and over.



Republic 6 in. hand operated valve

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

A.G.A. record convention planned

THE eyes of the gas industry will be turned upon Atlantic City, New Jersey, the week of October 7 when the 28th annual convention of the American Gas Association—the first full-fledged postwar meeting—takes place. Simultaneously, a great exhibition of gas appliances and equipment, sponsored by the Gas Appliance Manufacturers Association, will be held.

All signs point to this being the largest and most significant convention ever held in the gas industry. Advance registration indicates an attendance in the neighborhood of 10,000—an all-time high. Demand for space in the exhibition has already exceeded any other such event in the history of the gas industry.

Striking to the heart of vital problems, the convention gets under way Monday morning with meetings of the association's two departments. Under Chairman R. H. Hargrove, United Gas Pipe Line Company, the Natural Gas Department will spotlight discussions of natural gas reserves, pipe line flow research, volume sales, and recent developments in natural gas regulation.

The Manufactured Gas Department, led by Hudson W. Reed, chairman of the department and president of The Philadelphia Gas Works Company, has arranged for authoritative presentations on topics of major importance to manufactured and mixed gas companies. Speakers will include E. V. Murphree, vice president, Standard Oil Development Company, New York, on "Research —An Industrial 'Must'," and William W. Bodine, financial vice president, Penn Mutual Life Insurance Company, Philadelphia, on "The Financial Outlook of the Manufactured Gas Industry."

An important feature of the Manufactured Gas Department meeting will be a symposium on the outlook for raw materials for manufactured and mixed gas companies from the standpoint of their availability and future costs.

Putting a finger on one of the nation's foremost industrial problems, an employe relations forum will be held Monday afternoon under the leadership of Fred R. Rauch, chairman of the association's personnel committee, and vice president, The Cincinnati Gas and Electric Company. Introduced by Everett J. Boothby, president of the American Gas Association, this timely program includes such headline topics as: "Management's Stake in Collective Bargaining," by Dr. George W. Taylor, professor of industry, The Wharton School of Finance and Commerce, University of Pennsylvania; "A Program for Labor Peace" by C. B. Boulet, director of personnel, Wisconsin Public Service Corporation, Milwaukee; "Better Relations through Better Information" by W. H. Senyard, personnel director, Louisiana Power and Light Company, Shreveport. Discussion leaders will include M. V. Cousins, personnel director, United Gas Pipe Line Company, Shreveport, and F. W. Fisher, director of personnel and public relations, Rochester Gas and Electric Corporation.

The convention program committee, headed by Irving K. Peck, Manufacturers Light and Heat Company, Pittsburgh, has been tireless in putting together a general sessions' program of compelling interest. With President Boothby in the chair, the first general session opens Tuesday morning with a report on the association's finances by Edward F. Barrett, AGA treasurer, and president, Long Island Lighting Company, which will be followed by the election of officers for the 1946-1947 term.

J. A. Krug, Secretary of the Interior, Washington, D. C., addressing the Tuesday session will lead off an imposing array of speakers from outside the industry. Widely known and respected in the gas industry, Krug's background as wartime director of the Office of War Utilities and as chairman of the War Production Board, not to mention his former affiliation with the Tennessee Valley Authority, make him admirably equipped to discuss his topic: "The Government and Business."

The gas industry's stepped up program of research and promotion with its many-faceted developments will be placed before the industry in the annual report of the association's managing director, H. Carl Wolf. Speaking on "An Industry With a Program," Wolf will delineate the cardinal points in the industry's platform of progress.

Concluding the first general session will be an inspiring address on "Public Relations and Selling" by Arthur H. Motley, president, Parade Publication, Inc., New York.

The second general session, Wednesday evening, will be combined with an entertainment function wherein the business events will be followed by a musical concert. At this session Boothby will deliver his presidential address, which will review the high spots of his administration and present his views on the prospects of the gas industry in the competitive postwar period.

A feature of the evening session will be the presentation of awards for outstanding individual and company achievements during the year.

Guest speaker at the Wednesday general session will be Dr. Pierce Harris, minister, First Methodist Church, Atlanta, Georgia, ex-professional baseball player, and noted speaker on human interest topics.

The third general session, Thursday morning, will open with an analysis of the "Economics of Tomorrow's Business" by Prof. Erwin H. Schell, head of the business and engineering administration, Massachusetts Institute of Technology.

Focussing attention on the gas industry's greatest market, the American home, Robert F. Gerholz of Gerholz-Healey Company, Flint, Michigan, will present an informative summary of the latest trends in residential housing.

The well-known public opinion sampler and national marketing authority, Elmo Roper of New York, as the next speaker, will tell the gas industry "What the Public Thinks of Business." Backed by his experience as producer of the *Fortune* surveys, *New York Herald Tribune* analyses, and other widely-read and often-quoted opinion samples, Roper's address is expected to be a highlight of a star-studded program.

Returning to a subject that will have received concentrated attention at the employe relations forum, Warren Whitney, manager, National Cast Iron Pipe Division, James B. Clow and Sons, Birmingham, will talk on "Human Relations—Today's Management Challenge." Under his guidance Whitney's company has established an enviable record in safety and personnel matters and he will bridge the gap between the two sessions by emphasizing the importance and interrelation of these topics.

The general sessions will close with a report of the time and place committee on the 1947 annual convention, by N. T. Sellman, chairman, and vice president, Westchester Lighting Company, and a report of the resolutions committee.

A new feature of the convention program will be a publication editors' breakfast to be held Tuesday morning under the chairmanship of William B. Hewson, advertising manager, The Brooklyn Union Gas Company. Guest speaker will be Kenneth C. Pratt, head of his own firm of public relations consultants specializing in company reports and publications, and also editor of *Stet*, the house magazine for house magazine editors. Following Pratt's address, the meeting will be thrown open to a round table discussion of editors' problems.

Friday of convention week is being reserved for committee and other miscellaneous meetings, and for a final look at the gas appliance exhibition. Ample time has been allowed between sessions for a thorough inspection of the manufacturers' exhibits and no events are scheduled for Wednesday afternoon, thus allowing further time for this activity. ★★★

New and Improved

MACHIN PMENT

A REGULAR FEATURE
appearing in
THE PETROLEUM ENGINEER
700 Irwin-Keasler Bldg.
Dallas 1, Texas

(1) *Jacket oil heater*

To meet the industrial demand for an efficient, economical, low pressure heat transfer system for cylinder jackets and dies, The Youngstown Miller Company, subsidiary of Walter Kidde and Company, Inc., Belleville, New Jersey, announces a new line of jacket oil heaters.

Four standard sizes ranging from 14 to 65 kw. are available and special units to supply any volume of heat at temperatures up to 550 °F. will be supplied. Each compact, self-contained unit offers the following features: One, two, three, or more temperatures simultaneously; wide temperature range; accurate temperature controls; 5 to 150 kw. of heat or more if required; temperatures variable through manual selection; stationary or portable models.

The units occupy little floor space and can be installed quickly and inexpensively, requiring only a power line connection and a small amount of external piping. Heat is supplied by finned tube heaters through which heat transfer oil is pumped at a rate consistent with the conditions of service. As the heaters are not in contact with the oil, there is no fire hazard.

(2) *Taper attachment*

The Landis Machine Company, Waynesboro, Pennsylvania, has developed a 9/16-in. Lanco taper attachment die head having a capacity of ⅛-in. to 1/2-in. standard pipe threads.

The die head is of the rotary type and adaptable to any machine having either a leadscrew or lead cam. It can be supplied with special shank and flange required for adapting it to different machines.

Tapered threads are generated with the die head the same as straight threads in that they are formed with the chaser throat. This eliminates chaser leave-off marks when the die head opens, such as is experienced when using plunge cut or cutting tapered threads with full width of die.

The 9/16-in. Lanco taper attachment die heads fitted with alternating tooth tangential pipe chasers have proved extremely successful on the threading of stainless steel. The combination of die head and alternating tooth chasers prevents tearing on the crest of the thread because the chip is formed only on one side angle of the thread.

Keep Posted on
NEW EQUIPMENT
Use Card

Advancements in petroleum and plant equipment are being made rapidly. Keep abreast by making full use of *The Petroleum Engineer's* enlarged New Equipment Section.

All items are numbered. A business reply card requiring no postage if mailed within the United States is provided. Check or encircle the number on the card that corresponds with the product or products in which you are interested and drop it in the mail. Literature and prices will be sent promptly on receipt of card.

(3) *Funk "B" plane*

The Funk "B" high wing monoplane, manufactured by the Funk Aircraft Company, Coffeyville, Kansas, is designed to take executives, salesmen, ranchers, oilmen, and other business men to towns with small airports as well as to big city airports. A 37-mile landing speed allows an oil man, for example, to land in a small field near a drilling rig, and the plane's 800-ft. per min. climb and short take-off will speed him safely on his return journey, the manufacturer asserts.

The Funk "B" seats two persons side by side with ample luggage space. It has been termed an exceptionally easy flying plane by test pilots and amateurs alike, and has been proved extremely resistant to stalls and spins, it is stated.

Power is provided by an 85-hp. Continental engine that gives 20 miles per gal. at a cruising speed of 100 miles per hr. Top speed is 112 to 116 miles, and the 20-gal. fuel tank provides a cruising range up to 400 miles. Only 350 ft. is required for take-off at sea level.

Ground handling is aided by a new type, steerable, full-swiveling tail wheel and improved landing gear.

Other standard equipment includes quickly detachable landing lights, which can be carried in the luggage compartment when not needed, starter and generator, radio, a single piece plexiglas windshield, wheel pants, landing lights, dome light, illuminated instrument panel, and provision for the addition of special flight equipment.

(4) *New type tire*

An automobile tire that utilizes a new principle of increased air capacity at lower air pressure will be produced by United States Rubber Company as its first postwar premium tire, the company has announced.

Known as the U. S. Royal Air Ride, it will be marketed as a premium tire when government price regulations permit its release, reported W. D. Baldwin, sales manager of the company's U. S. Tires division.

"By combining 14 per cent more air volume and 8 per cent less air pressure, the new tire greatly enhances the cushioning effect an automobile receives from its tires," Baldwin stated.

"Additional features include a flatter tread and sharply defined shoulders to eliminate lazy rubber that normally tends to build up excess heat. Laboratory and road tests have revealed that the tire runs 10 to 15 degrees cooler, thus affording greater protection against blowouts and increasing the tire's mileage.

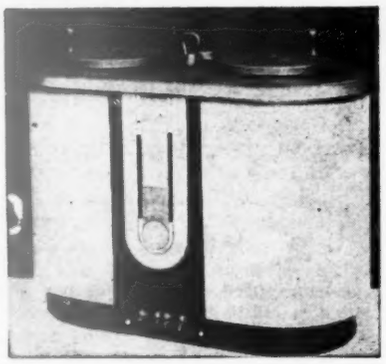
"The tread has been designed to meet new requirements, such as the virtual elimination of tire noise and the improvement of the car's stopping power. The vehicle is helped to a safe stop by perforations in the tread which open up when the car's brakes are applied."

The new tire will be of rayon construction in all sizes authorized by the government. It will be characterized by different size markings, such as "65-16" instead of "6.50x16."

(5) *Twin-unit welder*

A new twin-unit, outdoor a-c. arc welder in a single enclosure has been announced by the Electric Welding Division of the General Electric Company. Each of the two circuits in the welder can be used simultaneously and independently with electrodes up to ⅞ in. in diam., or combined into one circuit for heavy welding with ⅜-in. electrodes. The units have a current range of from 90 to 270 amp., when used singly, and from 180 to 540 amp. when operated in parallel.

Both welders are equipped with control that reduces the open circuit voltage to approximately 30 volts when the machine is



not welding, but makes full power available the instant the arc is struck. Both halves are supplied through a single set of primary terminals, so that only one power-line circuit to the unit is required.

Protection against rain, snow, and sleet is provided by dripproof construction of all openings in the top of the enclosure and by a sealed window over the current indicators. Ventilating openings at top and bottom are of such proportions that they shed water and keep the ventilating air velocity low.

(6) *Truck cost records*

A complete set of sample forms required to set up a simplified system of keeping operating cost records are available to truck owners upon request, according to M. E. Salzman, cost analyst of The Four Wheel Drive Auto Company, Clintonville, Wisconsin. The system was developed by the FWD service department during more than 35 years' truck manufacture and repair. This service is offered as an aid to owners who do not wish to set up an elaborate cost keeping system, but who recognize the fact that running a trucking business without reports is like using a clock without hands, Salzman said. A good set of records supplies the answers to these and many other questions: Is the truck efficient or has it outlived its usefulness? Is the gas mileage high? Low? Why? Which is the best size truck for the job? Which is the best truck for the job?

(7) *Welding fittings*

One of the most complete lines of stainless steel welding fittings to reach the postwar market is now being manufactured by Tube Turns (Inc.), Louisville, Kentucky, and is available through distributors in all principal cities, it is announced by Jack Green, sales manager of the firm's Welding Fittings Division. The line includes 180-deg. long radius returns, 90-deg. long radius elbows, 45-deg. long radius elbows, straight tees, reducing outlet tees, caps, eccentric reducers, concentric reducers, lap joint stub ends, laterals and crosses, all in standard and extra heavy weights; and welding neck flanges, slip-on flanges, threaded flanges, blind flanges, socket-type welding flanges, reducing flanges, orifice flanges and lap joint flanges. Sizes range from ¾ in. to 12 in.

The fittings may be had in three grades of stainless steel; Type 304, containing 18 per cent chromium and 8 per cent nickel; type 347, containing 18 per cent chromium, 8 per cent nickel, and approximately 1 per cent columbium; and type 316, containing 18 per cent chromium, 8 per cent nickel, and 2 per cent molybdenum. Surveys conducted by Tube Turns' Engineering Service Department and other research groups indicate that these grades meet 95 per cent of industry's standard requirements.

According to the manufacturer, the introduction of Tube Turns' complete line of stainless steel welding fittings gives the users two sets of advantages, each of which reinforces the other. They are:

1. The inherent advantages of stainless steel itself. It resists atmospheric corrosion, acids, and chemicals. It resists scaling at high temperature, and is strong and ductile at sub-zero and elevated temperatures. It has long life, reduces maintenance cost, virtually eliminates contamination, and has a clean and attractive appearance.

2. The advantages inherent in all piping systems fabricated with Tube-Turn fittings, whether of stainless steel, carbon steel, Monel, brass, copper or other metals. These are: Leak-proof joints, reduced weights, minimum flow resistance, low upkeep, great strength and safety, flexibility and streamlining.

Tube-Turns fittings, including those of stainless steels, are forged by a patented process. The result is a close grained, uniform metal structure with no locked in residual stresses.

(8) *New "Oilwell" rig*

Muscularly speaking, it is as easy to drill for oil thousands of feet below the earth's surface with the new heavy-duty rig of Oil Well Supply Company as to operate the average automobile. Five years of research by this subsidiary of United States Steel Corporation succeeded in banishing back-breaking tugs at a bank of man-size hand levers, which controlled drilling in the bonanza years of oil development.

Before the operator of the new rig stands a compact centralized control panel, resembling that of a giant army bomber. A flick of his wrist or a touch of his fingers to the knobs and levers control pneumatically the operations of the entire rig.

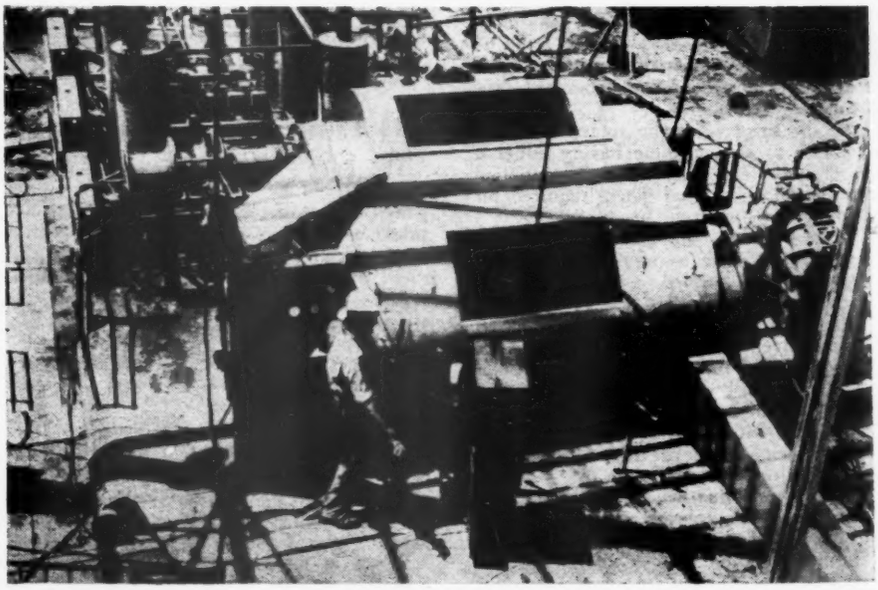
Small hand levers actuate air valves that operate all clutches in the drawworks transmission, on the compound drive, hydromatic brake, pumps, and sand reel. Similarly, hand throttles, also on the panel, control the three internal-combustion engines singly or in compound. Instruments showing air pressure, engine vacuum, transmission shaft speed, and oil pressure are before the operator's eyes. An auxiliary instrument panel in front of the drawworks shows pump pressures and bit weights as well as rotary speed.

Not only is the operation of this improved rig easy on the muscles of crewmen; it has also proved remarkably safe and speedy in the installations that have already been made. Built to bore a shaft 16,000 ft. down through hard earth, shale and rock—deeper, perhaps, if the need arises—the rig's designers hope to substantiate their theory that this new mechanical equipment will set a new high record for deep penetration.

The pneumatic operation is made safe and dependable by more than adequate compressor capacity. Three compressors, driven individually by the three engines, afford an immediate pressure buildup on starting any engine. As two compressors are capable of maintaining adequate air capacity and pressure the third is available virtually as a standby. The abundant engine power available for either hoisting or pumping, plus convenient centralized finger-tip control, saves valuable drilling time. A report on one installation indicates more than a month's time was saved in drilling to the 10,500-ft. Ellenburger pay depth.

Six forward and two reverse speeds are available. Ample braking capacity is provided through combination band and shoe type equalized brakes operating on series water cooled alloy steel flanges.

Safety is assured by complete guarding of all moving parts and a number of new advanced safety features. Special provision is made for maximum accessibility of inspection and maintenance of all moving parts. For moving from site to site, the power compounding assembly is disconnected into five units, each of the prime movers being mounted on a skid type sub-base. The drawworks moves as a single load 21½ ft. long, 9½ ft. wide, and 8¼ ft. high. By unbolting the transmission from the drawworks an 8-ft. road clearance may be obtained. Thus great portability, long a bugaboo with deep drilling rigs, is accomplished to lower the time and cost of moving.



COMPLETE STOCKS AT ALL STORE POINTS

Republic Sales and Service Points

Republic Supply COMPANY

GENERAL OFFICES . . . . HOUSTON, TEXAS

(9) *All-position electrode*

The new Airco No. 87 electrode is a general purpose, mild steel electrode operating exceedingly well on d-c. straight or reverse polarity and on a-c., producing a weld metal of high mechanical properties. It is especially recommended by the manufacturer for low-cost, single- or multiple-pass welding on plates or sections where the fit-up is poor, or the work is rusty or dirty.

Now available in quantities, this improved electrode has many features. Briefly enumerated, the following points emphasize the most outstanding benefits to the operator, according to the manufacturer:

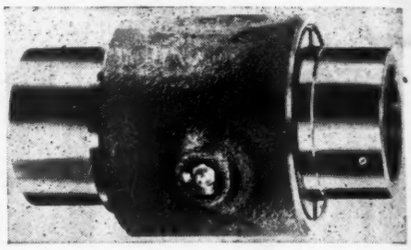
1. Capable of producing excellent welds over wide current ranges for any given diameter.
2. This electrode is outstanding in that the performance characteristics are substantially the same when using d-c. straight polarity, d-c. reverse polarity or a-c.
3. Excellent results are obtained in all positions.
4. Has exceptionally high deposition rate.
5. Has very high deposition efficiency.
6. Arc action is such that the less skilled operators can produce excellent results at high speeds even on lighter gauge metals.
7. Conforms to A.W.S. Classification E-6012 and is marked in accordance with NEMA standards.

Although the new electrode's applications are numerous in varied industries particularly where welding of poor fit-up is to be successfully accomplished, some specific uses are: Storage tanks, steel structures, sections of hopper and boxcars, ducts and ventilating equipment and general maintenance and repair work in railroad shops, foundries, etc.

(10) *Swivel fitting*

The Earle R. Atkins Company, Huntington Park, California, is now producing under the trade name of ERAC, a complete line of single, double, and triple swivel ball-bearing fittings for high pressure applications.

ERAC swivel fittings are designed to eliminate torque, and are flexible at all pressures, being restricted to free turning only by the friction load on the double rows of balls, and the internal pressure exerted on a small section of the self-sealing packing unit at the point of rotation. The double



rows of balls are widely spaced to maintain perfect alignment and roll on hardened and ground wear plates. Wear on the ball races may be compensated for by an easily adjusted thrust nut. The specially moulded one-piece packing unit provides a tighter seal with increased pressures. It is neither necessary to remove fitting from the line nor to completely disassemble it when repacking or adjusting thrust nut, thereby allowing quick repair service on the job.

ERAC high pressure fittings will be available in sizes from ½ to 4 in. with threaded, flanged, or welded ends. Oil field specialties such as circulating heads, mud mixing guns, cementing hose, etc., are part of the new ERAC line. Atkins, who heads the company, has been associated in the swivel fitting industry for many years, and fully understands the needs of those faced with the problem of moveable lines at high pressures. Swivel fittings for low pressures and steam service will complete the line.

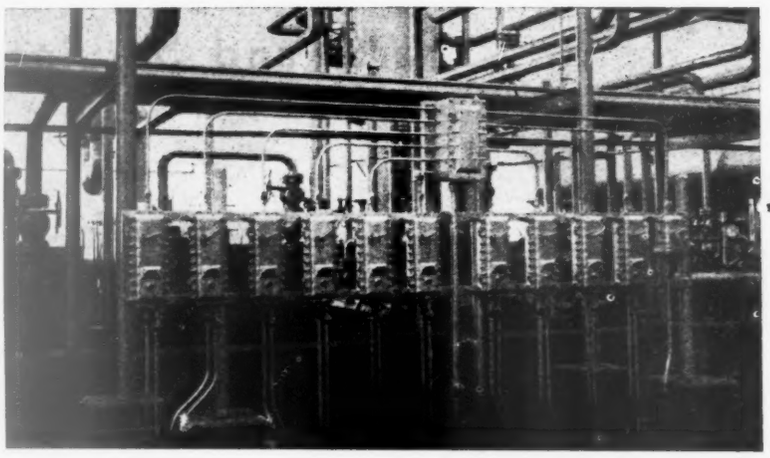
(11) *Steam cleaner*

A new postwar, streamline design steam cleaning machine known as Model JO Hypressure Jenny Instantaneous Steam Cleaner has been announced by Homestead Valve Manufacturing Company of Coraopolis, Pennsylvania.

Model JO Hypressure Jenny Steam Cleaner is a compact, portable, streamlined, steel-fabricated, electric-welded unit with all machinery end-mounted and fully accessible. It can be supplied with or without a removable, die-formed steel machinery cover. Large, semi-steel wheels and a steering tongue afford easy portability and maximum utility permitting easy transfer from one cleaning job to another, the manufacturer asserts.

Cleaning is accomplished by a highly atomized mixture of steam, hot water, and cleaning compound applied under pressure through a spray nozzle. Normal operating pressures range from 80 to 120 lb. at 90 gal. per hr. water capacity. Where powerful flushing and rinsing action and extra water capacity are required, the use of the Adjusta-Blast Gun is recommended, which increases water capacity up to 480 gal. per hr.

Motor Starters and Rack Assemblies



Above photograph shows NEMCO Class 481 Explosion-Proof Junction Box with Low-Voltage Busses and Class 420 Combination Motor Starters, mounted on fabricated Steel Rack. Installation is on a prominent oil company's gasoline and repressuring plant in Texas.

Reduce field labor and speed-up job completion. Shipped as a complete unit, on skids, facilitating ease of mounting. Wired as a complete unit, ready for incoming feeder and outgoing conduit connections to motors.

Tailor-made to suit your individual requirements. Write for complete data, giving full information as to your requirements and type of installation desired.

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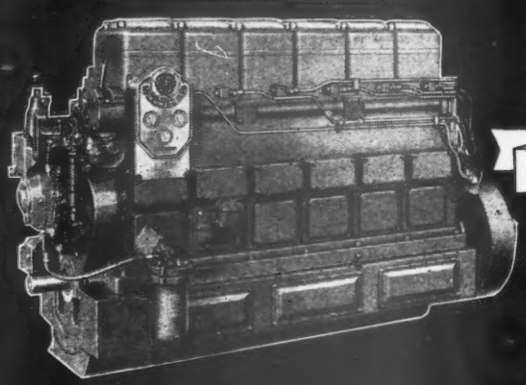

CUMMINS DIESEL

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CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA

to *Corrosion* costs?

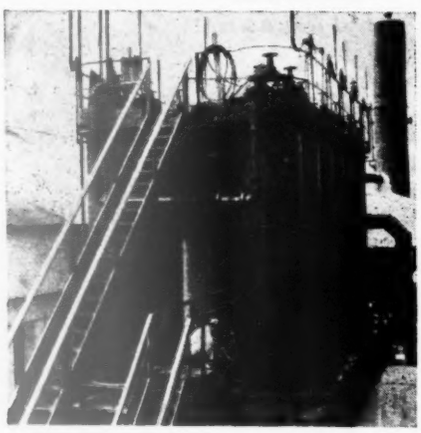
One of the largest petroleum companies in the world uses Amercoat plastic coatings for corrosion control in their refineries.

The illustration below shows a battery of 12 ammonia condensers, a part of the refrigeration plant. All of the structure visible in the photograph has been coated with Amercoat. Sea water is used as a coolant and the entire structure is subject to constant salt spray, as well as ammonia and acid fumes.

Previously, in spite of regular painting and maintenance, corrosion continued and was approaching an operation danger point due to high tank operating pressures. After Amercoat was applied in July, 1944, there was no further maintenance, yet two years later all tanks and piping showed no signs of further corrosion—stairs, walkways and other structures subject to mechanical and manual abrasion showed a minimum of corrosion.

Amercoat plastic coatings applied cold by brush or spray to metal, concrete or wood act as a barrier to corrosive action encountered in the petroleum industry—salt water, hydrogen sulphide, caustic soda, sour crudes, sulphuric acid, and many other corrosive salts, acids and alkalies.

Write for details and names of users.



IN THE PETROLEUM INDUSTRY IT'S

Amercoat

PLASTIC COATINGS

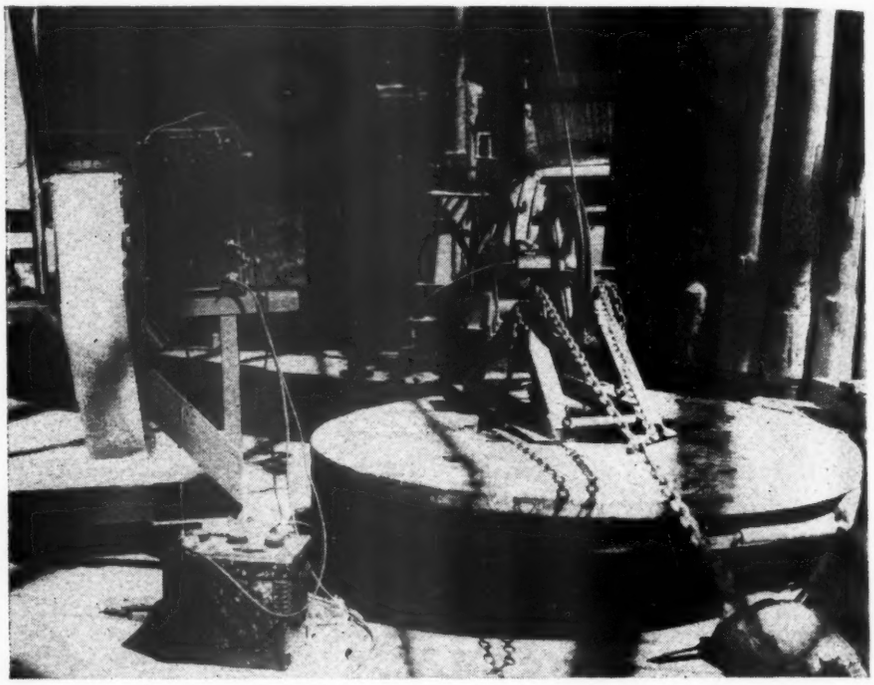
Ask for Booklet 2-B

AMERCOAT DIVISION:
AMERICAN PIPE & CONSTRUCTION CO.
P.O. Box 3428, Terminal Annex
Los Angeles 54, Calif.

(12) *Well logging unit*

Halliburton Oil Well Cementing Company, Duncan, Oklahoma, has developed a new portable device for electrical logging of shallow wells, primarily core holes, seismograph shot holes, and water wells. Its compactness and simplicity of operation enables a person unskilled in electronics to operate it, according to the manufacturer.

The recording unit is 2 ft. by 1 ft. by 1½ ft. in size and weighs approximately 50 lb. The capacity is for 2500-ft. log, 5¾-in. wide. The logging scale is 1 in. equals 50 ft.; different scales may be made by using special gears. The stylus is fully automatic; recording capacity, 150-ft. line spaced per minute. Anti-backlash gear synchronization gives improved depth correlation, the manufacturer states. There are no complex camera adjustments; the log as finished copy can be inspected as recorded. The equipment will make one curve per trip and the curves available are potential, single point impedance, and caliper.



(13) *Oil seal packing*

A new type of oil seal packing, developed by the Johns-Manville research laboratories for the protection of bearings, is announced by H. R. Poulson, manager of the packing department.

Using no metal, the new oil seal has a high factor of heel rigidity and a soft flexibility. It is now being manufactured at the Johns-Manville plant at Manville, New Jersey.

The new product is known as Clipper Seal and is made with a heel of resin bonded fabric giving it the rigidity essential for a press fit in the cavity and with a lip of a tough but soft flexible compound. The special lip design makes it possible to vary the bearing area and control the pressure of the lip against the shaft by means of a garter spring, thereby reducing shaft wear to a minimum.

Its one-piece precision-made body, concentrically molded and nonmetallic in construction, permits relatively liberal machining tolerances. Its compact shape makes possible a light flange section that effects compactness of machine design.

In service, these features of the Johns-Manville Clipper Seal provide a positive lubricant-retaining, dirt-excluding seal, automatic in operation, adaptable to a wide range of conditions, and highly resistant to most forms of corrosion.

Clipper Seals are made in sizes for shafts from 1⅞ in. to 37 in. diam., in both endless and split types. Special designs are available where unusual temperature, pressure, or chemical conditions require.

(14) *Truck crane*

A new Koehring 304 truck crane has been announced by the Koehring Company, Milwaukee, Wisconsin. Lifting capacity is 40,000 lb. with outriggers, 15,800 lb. without outriggers. Both are 85 per cent ratings.

The same base machine used by Koehring on their 304 crawler model is utilized on the 304 truck crane. Extra strength regularly built into this machinery makes it possible to turn extra stability gained by truck mounting into extra lifting capacity.

Designed for easy handling on street or highway, the Koehring 304 truck crane travels right along with traffic. Where trucks can go, it goes. Because of its high travel speed, unproductive job-to-job moving time is reduced to the minimum.

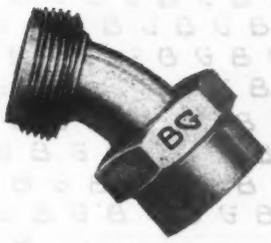
Hinged boom folds easily, saves time whenever the machine is moved. Pendant boom suspension simplifies changes in boom length and materially reduces the cost of boom suspension cable. Booms are available in lengths up to 110 ft. Jib boom extensions are in 15 ft. to 30 ft. sizes.

Removable outriggers are optional, permit efficient operation as a shovel, pull shovel, or dragline.

(15) *Geared pipe threader*

A quick-setting workholder and new balanced loop handles are two innovations on the new 4P geared pipe threader announced by the Ridge Tool Company, Elyria, Ohio. The quick-setting workholder affords an advantage in enabling a worker to set the threader exactly to size before being placed

BG E-463 ELBOW
90 DEGREE ANGLE



BG E-511 ELBOW
150 DEGREE ANGLE

THE BG RB-312-S INDUSTRIAL SPARK PLUG AND ASSEMBLY

A BG spark plug designed, engineered and developed specifically for industrial use.

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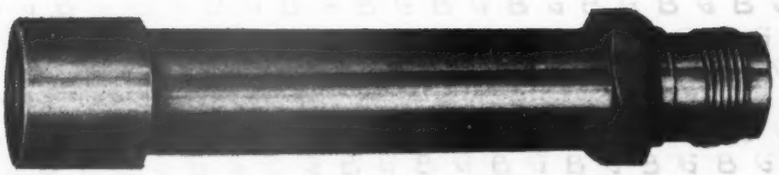
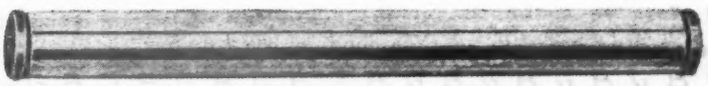
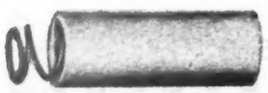


BG M-695 BARREL EXTENSION



BG M-688 TERMINAL SLEEVE EXTENSION



BG M-531 TERMINAL SLEEVE

BG RB-312-S SPARK PLUG WITH M-695 BARREL EXTENSION AND E-511 ELBOW, 150 DEGREE ANGLE

BG RB 312-S

on the pipe; once on the pipe only one screw needs to be tightened to hold it securely. All bothersome bushings have been eliminated. The balanced loop handles on the enclosed gear case prevent slipping or tipping over, making it easy to pick up and put straight on the pipe, and easy to carry with one hand.

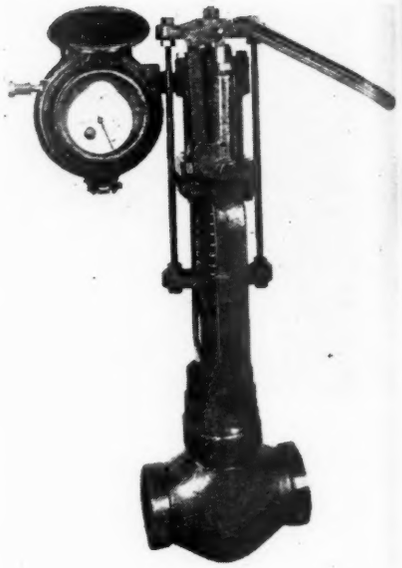
The manufacturer also claims economy of operation by virtue of a twin-anchored drive shaft that turns in oilless bronze bearings. No oil is needed. The gear is fully enclosed, packed in grease, protected from dirt and wear.

Precision made of rugged steel-and-malleable, the new 4P is provided with four sets of five high-speed steel dies to cut clean, accurate threads, standard or tapered. drip threads and short nipples. A ratchet handle is provided with each 4P and a special Ridgid design universal drive shaft is available for power drive. Production is said to be still limited; distribution through supply houses only.

(16) *Shut-off valve*

The Enardo clock-controlled shut-off valve was designed for use in closing in flowing wells after a preset flowing time has elapsed. It is so constructed that the closing is slow and uniform so as not to create pressure shock to connected equipment, well tubing, etc.

The complete valve consists of a forged-steel single-seated valve body of 1500-lb. working pressure. The top works consists of a hydraulic cylinder, a powerful hydraulic pump for manually opening the main valve, and a clock-actuated pilot valve that by-passes hydraulic fluid from beneath the hydraulic cylinder piston to the top side of the piston to permit the main valve to be closed by spring force. A metering screw in the fluid bypass connection can be set to permit the main valve to close with most any desired speed of movement, thus the main valve can be caused to close very slowly, eliminating upstream shock.



The clock is a hand wound 24-hr. movement and can be set to open the bypass pilot up to approximately 22 hr.

The Enardo shut-off valve is completely self-contained, requiring no outside air or gas supply for operating power.

(17) *Welding head*

Improvements of its welding head designed to simplify production installation setups and increase speed of operation, are announced for its "Lincolnweld" hidden-arc process of automatic metallic shielded arc welding by The Lincoln Electric Company, Cleveland, Ohio. The new, improved head is designated as the "LAF-2".

To further expand its use on sheet metal work, the "LAF-2" has been designed to accommodate 3/32-in. electrode. The head is shipped with the same lower wire contact jaws as the previous head designated as "LAF-1," which accommodates electrode wire ranging from ⅛-in. to 7/32 in., but an extra movable tapered contact jaw is supplied that can be quickly interchanged if 3/32-in. wire is desired.

The controls of the "LAF-2" have been modified to simplify arc starting. Now all that is required to start the arc is to turn a single control switch to the "Down Weld" position. This causes the electrode to feed down until the end touches the work piece. Short-circuiting the wire to the plate automatically causes the wire feed motor to stop. The flux valve is then turned on and the arc started by means of a push button. The arc is extinguished and the electrode is withdrawn by moving the operating switch from "Down Weld" to the "Up" position.

Another innovation is the use of plugs and receptacles that simplify and radically reduce installation time for the "LAF-2" head. Two receptacles are mounted in the automatic control box and plugs are attached to one end of the cable coming from the welder supply and one end of the cable coming from the head itself.

BEAT

Soil Corrosion

This machine, especially developed for J-M by Crutcher-Rolfs-Cummings of Houston, double coats *and* double wraps *in* one *operation.*

in ONE operation with this Johns-Manville Machine

As fast as pipelines can be assembled, the Johns-Manville machine pictured here applies *double* protection against soil corrosion. TWO coats of enamel . . . TWO layers of J-M Asbestos Felts . . . go on in ONE single operation.

That means installation savings. And these savings continue through years of service because Johns-Manville Pipeline Felts are made of time-defying, rotproof asbestos fibers. It is today the most widely used material for guarding the enamel against soil stresses and distortion.

For complete information, write Johns-Manville, Box 290, New York 16, New York.

JM PRODUCTS

Johns-Manville *ASBESTOS* Pipeline Felts

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 26th YEAR

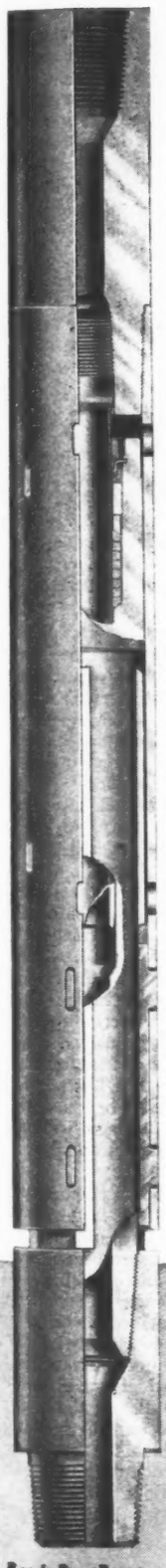
HERE'S A TOOL WITH A

2-Way Saving

1 Safeguards the drill string against sticking

2 Increases drilling efficiency

The BAASH-ROSS DRILLING TYPE BUMPER SUB



Baash-Ross Bumper Sub—Drilling Type.

WHEN YOU put a Baash-Ross Drilling Type Bumper Sub on your drill string you're installing one of the best safeguards yet developed against costly fishing jobs. For the Baash-Ross Drilling Type Bumper Sub is specially designed with the necessary ruggedness and engineering features to withstand the continuous vibration and severe torque load of modern high-speed drilling operations. A particularly important design feature is its renewable spline inserts that take all of the wear. You can renew this Bumper Sub after long periods of use by simply replacing the spline inserts—a simple and inexpensive operation.

SPLIT-SECOND ACTION

Renewable spline inserts are just one of several features that make the Baash-Ross Drilling Type Bumper Sub unique and permit it to be used continuously *right in the drill string* with negligible maintenance and attention. Whenever you're drilling in heaving, sticky or difficult formations, install the Bumper Sub directly above the reamer, the bit or other large-diameter sections that are apt to get stuck. Should the drill string stick, you can *instantly* start jarring to loosen it. You can jar *up*... or you can jar *down*. Or you can even alternate up and down jarring, if desired, without making any adjustment whatever in the tool. In addition, you can instantly control the force of the blow—heavy or light—to meet any requirement.

By having a tool *right in the drill string* with which to jar the pipe loose the instant it sticks, one of the major causes of costly fishing jobs is eliminated. The time to loosen stuck pipe is the moment it sticks—not after cuttings have had a chance to settle and wedge the string tightly in place. The Baash-Ross Drilling Type Bumper Sub gives you this split-second safeguard against costly fishing operations.

IMPROVED WEIGHT CONTROL

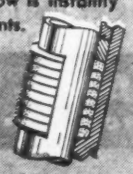
But that is not all. Many operators are also using the Baash-Ross Bumper Sub to increase the efficiency of their drilling operations by installing it as a telescoping "free" joint between the drill collars and drill pipe. Then, by regulating the weight of the drill collars, they can maintain continuous and accurate control on the weight placed on the bit by simply keeping the Bumper Sub joint partly open as they drill. Yet at any time they can immediately increase or decrease the weight on the bit in the normal manner should thin strata of hard or soft formations make such changes advisable.

Regardless of the nature of your drilling operations, you will find the Baash-Ross Drilling Type Bumper Sub an invaluable aid. Get the full details on this tool from your nearby Baash-Ross distributor... or write direct.

Only the Baash-Ross Drilling Type Bumper Sub has all these advantages!

Quickly Renewable Spline Inserts: Replaceable spline inserts take all the wear. After long periods of service, simply replace the spline inserts—a quick and inexpensive operation—and the Bumper Sub is as good as new. Minimizes wear on body and mandrel!

Drives Up or Down: No adjustment is necessary in the tool to jar either upward or downward—or to alternate up or down blows. Also, intensity of blow is instantly variable to meet requirements.



High Pressure Pack-Off: Under even the highest drilling pressures the Baash-Ross Bumper Sub will not leak because of the unique heavy-duty multiple-ring packing element between the body and mandrel. This unit packs off over the full stroke, and may be readily replaced whenever necessary.

16 Inch or 24 Inch Stroke: Take your choice—the Baash-Ross Bumper Sub is available in both 16 inch and 24 inch strokes... or can even be supplied with other length strokes on special order.

Wide Range of Sizes: Available for both API Regular and API Full Hole strings in a complete range of sizes.

A new, simplified wire straightener has also been added that makes it easier to insert the starting end of the wire and effect more positive wire straightening.

The "Lincolnweld" process is designed for use with direct current, utilizing a bare metallic electrode that is fed through a granular flux deposited on the joint to be welded. Sufficient flux is applied to completely cover the arc and the molten metal; the unfused flux is then reclaimed for further use.

It has been successfully used in welding all types of joints including plug, butt, lap, edge, fillet, and corner, the manufacturer states.

The welding head is normally used in conjunction with a specially built automatic welding set of 1200-amp. capacity. The current rheostat in the automatic control box permits a current range of 300 to 1200 amp. The unit has two exciters, one for the automatic head control and one for the welder field excitation. The welder control box has provisions for easy and quick wiring of the automatic.

Direct current offers many important advantages over alternating current; such as a more simplified and positive control; ability to weld non-ferrous materials, and better control of electrode melting rate through the option of either straight or reverse polarity.

Extremely high current densities are used. For example, ⅛-in. diam. electrode may carry as much as 650 amp. This produces greater penetration and permits smaller cross-section of weld metal with resulting saving in cost and reduced warpage and distortion.

The standard head is changed from butt to fillet welding in a matter of only a few minutes. In making fillet welds the lower wire guide and flux tube are changed from straight to curved, thus permitting the head and wire reel to be left in its normal position. The wire is fed in at 40 deg. from horizontal, which gives the maximum effective throat for horizontal fillet welds.

(18) *Pebble heater*

The Babcock and Wilcox Company has developed a new form of heat transfer unit, called the "pebble heater," capable of heating gases above the operating temperatures permissible in metallic heat interchangers. The principle involved consists of raising to high temperatures a constantly moving column of pebbles made of a heat resistant non-metallic material, and then passing the gas to be heated through the interstices of the moving pebble column.

C. L. Norton, Jr., technical director of the company's Refractories Division, said that this unit has been successfully used to heat air to 2300°F. and steam to 1800°F.

"For a long time," Norton said, "there has been need for a unit that could heat steam to higher temperatures than could be maintained in metallic heaters, operate at moderate to high pressures, and maintain a uniform non-fluctuating temperature of the heated steam. The pebble heater was developed as a result of these requirements."

"One of the first applications of the pebble heater has been for heating the air used for combustion of fuels," Norton said. "By using highly preheated air, temperatures can be reached which have been generally considered to belong in the field of electric furnaces, and far exceed the temperatures required for melting steel.

"In the field of refractories, which covers the making of materials for furnace constructions, a continuous melting operation has been developed in which furnace construction materials, in themselves very resistant to high temperatures, can be melted and poured like molten steel, to give them even greater temperature resistance."

It was pointed out that another interesting development in connection with the melting of refractories is the production of a refractory mineral fiber or "wool", which is said to be capable of a much higher temperature use limit than the usual mineral or glass wools on the market. Mineral fibers made with this apparatus can be used in chemically corrosive applications, for filtering out dust from high temperature gas streams, and as a packing material to fill expansion joints in refractory furnace construction, where other available materials would fail as a result of intense heat, it is asserted. These fibers can also be used to advantage as heat insulation where weight is important, such as the insulation of jet motors.

In the general field of process chemistry, the pebble heater, because of its large heat transfer surface is particularly suited for rapid heating of gases to high temperatures.

The heater is described as consisting of two cylindrical chambers, one above the other, connected by a throat section of reduced diameter. By filling the chamber and throat with refractory pebbles, permeable beds are formed through which gases can be made to travel. At the outlet of the bottom chamber, there is a mechanical feeder that controls the rate at which the pebbles are conveyed continuously back to the top of the upper chamber. The pebbles in the heater move downward at a constant rate during the entire operation.

FOR ASSURED...DEPENDABLE TRENCHING PERFORMANCE AT MINIMUM OPERATING AND MAINTENANCE COST ON LONG AND SHORT LINES FOR WATER... SEWER...GAS...TELEPHONE...OIL...POWER ...DRAINAGE...FOUNDATIONS...AIRPORTS

Incorporating the engineering features that more than 25 years experience have proved most desirable CLEVELANDS have everything you'd ask for, for "Tops" in trenching performance.

They're fast — amply powered — maneuverable — mobile — versatile — easy to operate — sturdily constructed — in fact they have just those features that enable you to make short work of the trenching jobs and show a profit.

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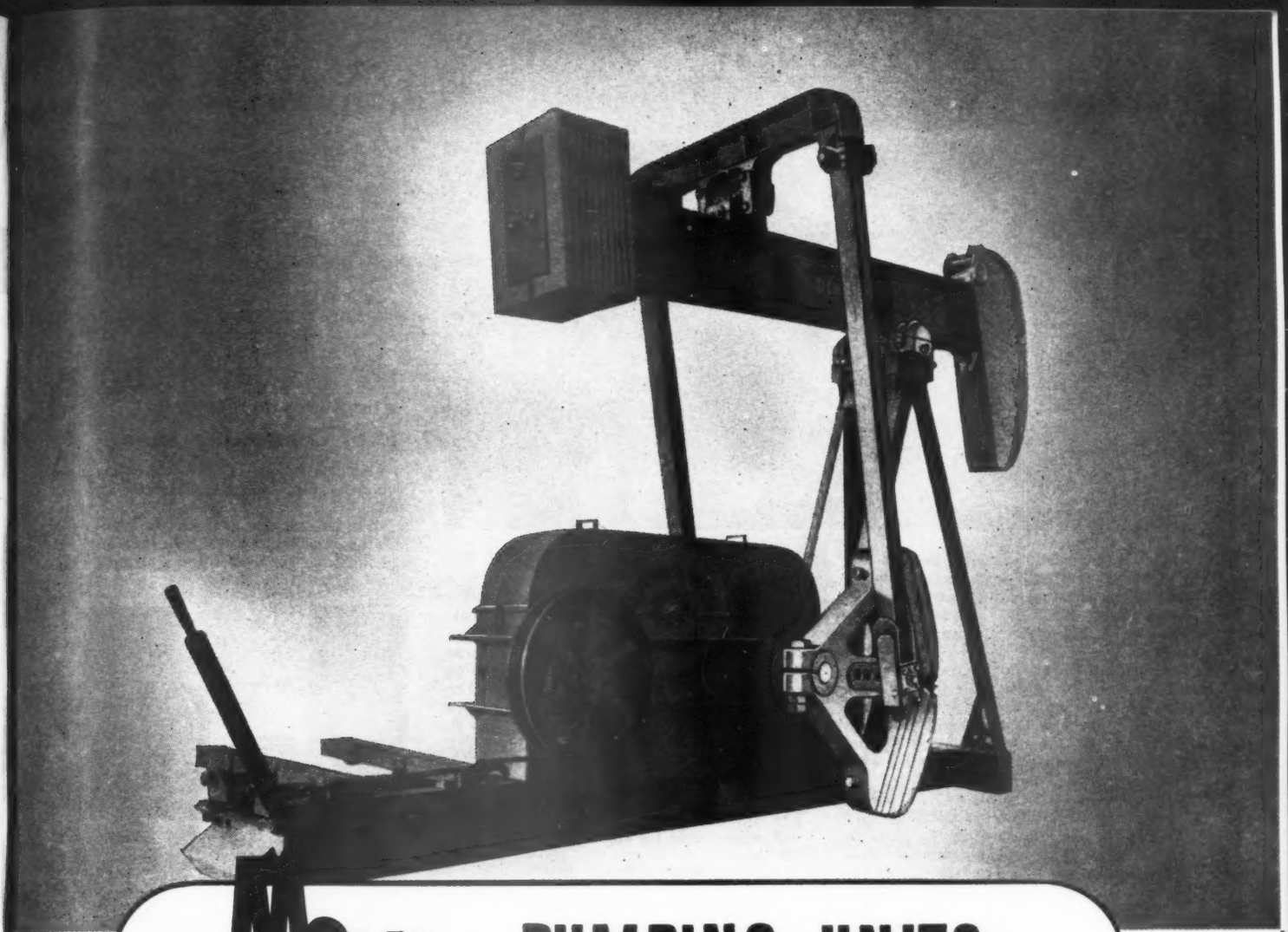


Moore PUMPING UNITS ..

If maintenance, repairs, and down-time are running up your pumping cost it's time to set a Lee C. Moore Pumping Unit. These *chain driven,* double reduction, twin crank units have fewer parts to wear out, sturdier moving parts to resist wear and a patented chain adjuster that enables a pumper to keep the unit at top operating efficiency.

A wide range of pumping well requirements can be met by Lee C. Moore Units. Requirements can be supplied from stock in most fields.

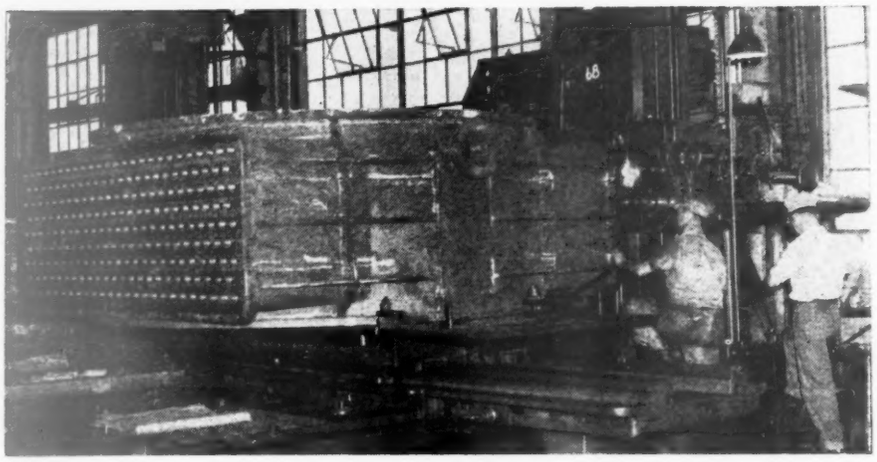
CONDENSED SPECIFICATIONS

Double Reduction — Twin Crank

Model	H.P.	Torque	Strokes	Drive	Patented Chain Equalizer
28DT139	28	139,000 in. lbs.	24-34-44-54"	Double Strand Roller Chain	Yes
21DT105	21	105,800 in. lbs.	24-34-44-54"	Single Strand Roller Chain	Yes
14DT69	14	69,500 in. lbs.	24-30-36-42"	Single Strand Roller Chain	Yes
9DT45	9	45,250 in. lbs.	18-24-30-36"	Single Strand Roller Chain	Standard Adjuster

Moore Service from field stores located in Kilgore, Odessa, Wichita Falls, Centralia, and Great Bend.

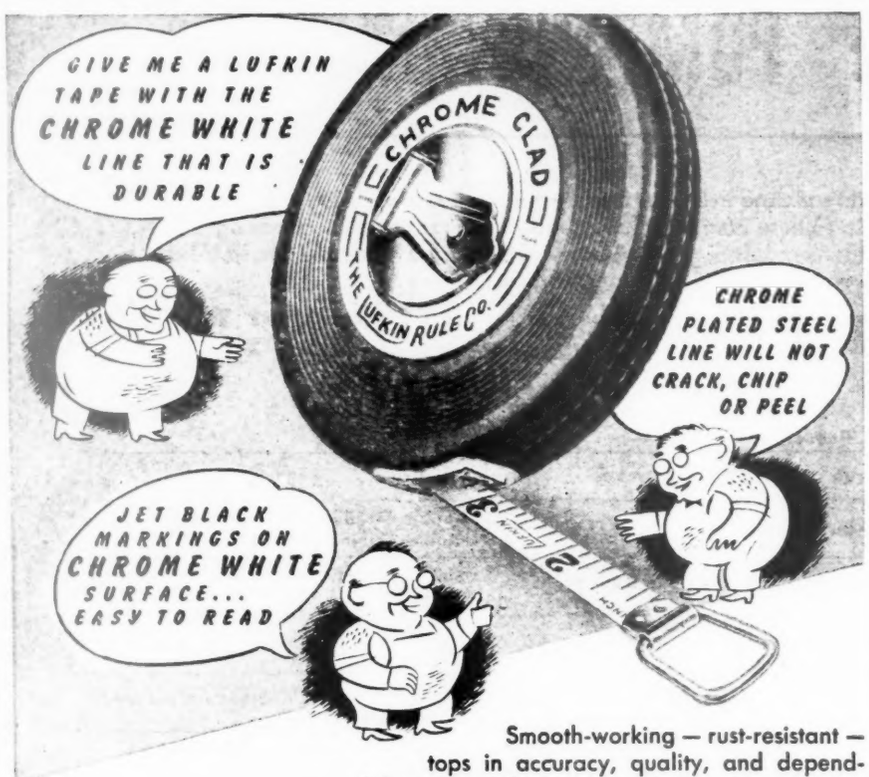
(19) *Cooling coils*



The largest castings to be poured and machined in the south were recently manufactured in the modern plant of Lufkin Foundry and Machine Company, Lufkin, Texas, according to a report from that company.

These castings are to be used in a distillation and absorption tower for ammonia stills, which, when completed, will be 282 ft. 6 in. high. The castings will range in weight from 8000 to 12,000 lb. each. On the flat side of the castings they are drilled with 884 holes ranging from ⅞ in. to 2 13/32 in. to be equipped with cooling coils. Machine tolerances are held between 0.002 in. and 0.050 in. The material used in the castings conforms strictly to specifications of class 30 iron ASTM specifications A-48-29. The minimum transverse breaking strength is 2200 lb. on a 1-ft. 2-in. diam. bar 18 in. between centers and the minimum tensile strength is 30,000 lb. per sq. in. According to laboratory tests, the iron used in these castings considerably exceeds the minimum requirements on the transverse bar test. The typical chemical analysis is carbon 3.00 to 3.5; silicon 2.00 to 2.5; manganese 0.50 to 1.00; phosphorus 0.15 to 0.30; sulphur 0.10 to 0.20.

Castings must be free from steel welding and made without the use of chaplets. The approximate weight of the completed still, when ready for operation, will be 800,000 lb.


GIVE ME A LUFKIN TAPE WITH THE CHROME WHITE LINE THAT IS DURABLE
CHROME CLAD
THE LUFKIN RULE CO.
CHROME PLATED STEEL LINE WILL NOT CRACK, CHIP OR PEEL
JET BLACK MARKINGS ON CHROME WHITE SURFACE... EASY TO READ

Smooth-working — rust-resistant — tops in accuracy, quality, and dependability. Available with hook-ring for one-man measuring. Get the best — get Lufkin Chrome Clad Steel Tapes from your supply house. Write for free catalog.

LUFKIN

THE LUFKIN RULE CO., SAGINAW, MICHIGAN, New York City

(20) *FWD truck*

Manufacture of the FWD Model M10, which was virtually out of production during the war, is being resumed, according to officials of The Four Wheel Drive Auto Company, Clintonville, Wisconsin.

Among the improvements in design on the M10 are the FWD Universal cab, which features a number of comfort and safety advantages, a sturdy streamline radiator grill, and improved heavy-duty axles. Engines with higher horsepower rating will be installed in the M10. The standard engine is a gasoline 186 b.hp. engine with a customer's option on the installation of a 200 b.hp. diesel engine. The rated gross vehicle weight of the Model M10 is 44,000 lb.

(21) *Cementing shoe*

The new Baker Triplex Cementing Shoe combines three distinct features into one unit:

1. It has all the well known features of the Baker cement whirler float shoe for guiding, floating, and cementing a string of casing;

Fig. 1 Fig. 2

2. The metal petal basket attached to the triplex shoe forms a bridge, even in an irregularly shaped hole, to prevent the cement slurry from settling into permeable low-pressure zones below the shoe;

3. All cement slurry is directed through the side whirler ports and a reinforced resilient rubber sleeve-type back-pressure valve prevents a return flow of the cement slurry. This eliminates the necessity of maintaining pressure on the casing to prevent the cement from backing up the pipe.

Secured to the lower end of the casing, the triplex shoe operates as a conventional float shoe (see Fig. 1) during the running-in, washing, and hole conditioning operations.

After proper conditioning of the mud, the tripping ball (drillable) is pumped, or allowed to gravitate, down to engage the tripping valve. A pressure of 400 to 500 lb. per sq. in. is applied to the casing, which shears the screws in the tripping valve and permits it to move downward exposing the cement ports and releasing the strap around the basket, thus allowing the basket to expand outwardly against the wall of hole. (Fig. 2).

The cementing operation is then carried on in the conventional manner. The cement is forced out the side whirler ports, as the central passage of the shoe is plugged off by the tripping ball.

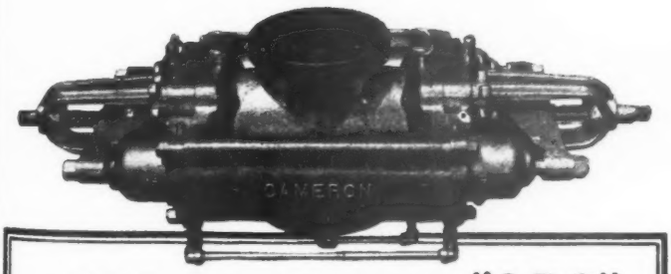
All internal parts of the Baker Triplex Cementing Shoe are made of readily drillable materials. The overall O.D. of the triplex shoe is approximately ½ in. larger than the O.D. of a standard casing coupling.

why spend HOURS to do the job that can now be done in MINUTES?

Quick Ram Change

CAMERON BLOWOUT PREVENTERS

will pay for themselves in the rig time they save



QUICK FACTS ABOUT "QRC"

- Quick Ram Change—Whereas many hours of hard labor were required for this operation on earlier models, rams can now be changed in a matter of minutes.
- High Closing Ratio — 1000 lbs. closing pressure will close the rams against approximately 8000 lbs. well pressure!
- Well Pressure Equalized Front and Back of Rams—Well pressure is bypassed to rear of rams where it aids in closing, thus contributing to the more favorable high closing ratio.
- Weighs 30% Less Than "SDA" Models—Compact design facilitates transporting the unit as well as its assembly in the field.
- 10,000 lbs. Test Pressure Models—6" and 10" sizes available in both 6000 and 10,000 lbs. test.
- Plus—Patented self-feeding ram packing, fluid pressure operation by remote control, self-centering rams and other time-tested mechanical features.

A major oil operator, one of the largest owners of rotary drilling rigs, is replacing all of his blowout preventers with Cameron Type "QRC's." This decision is the result of a study of the cost of changing rams in the Type "QRC" as compared to other models. Whereas the rams in the largest size "QRC" preventer can be changed in as little time as 15 minutes, ram changing in large sizes of other models sometimes requires up to 15 hours or more. With from three to five ram changes required in the average Gulf Coast well, for example, the operator can quickly offset his investment in these new drilling control units by the saving of rig time.

Complete details will gladly be sent to interested operators on request.

CAMERON IRON WORKS, INC.

711 Milby St., Houston, Texas

Export 74 Trinity Place, New York, N. Y. *West Texas* Telephone 1710, Odessa. *Oklahoma* 310 Thompson Bldg., Tulsa. *California*: H. G. (Jeff) Musolf, 1442 Hayes Ave., Long Beach (7-2036)

TRADE LITERATURE

Publications listed are sent free upon request.

(22) *Oil Well Supply catalog*

Oil Well Supply Company, Da las, Texas, has issued the 1946 edition of its general cata og. Illustrated and described in detail are the many items of equipment that this company manufactures for the several branches of the oil industry.

(23) *Emsco Rotary*

A leaflet issued by Emsco Derrick and Equipment Company, Los Ar geles, California, shows the Emsco JCS-20½ rotary machine, and illustrates many of the features built into the Emsco table.

(24) *Drilling rigs—servicing units*

Wagner-Morehouse, Inc., Los Angeles, Ca ifornia, has issued a new catalog, No. 46, covering its complete line of mobile drilling rigs and well servicing units.

(25) *Flexible couplings*

The American Flexible Coup'ing Company, division of J. A. Zurn Manufa turing Company, Erie, Pennsylvania, has issued catalog No. 46'. In addition to photographic illustrations and complete descriptive detail, considerable engineering data on couplings are given in the form of tables.

(26) *Process pumps*

Ingersoll-Rand Company announces the publication of a 12-page, 2-color bul'etin entitled, "Process Pumps," which describes the company's line of single-stage pumps buil't for general service in the refinery, process, coke by-products, and related industries. Quoting the catalog, "these pumps will handle liquids at temperatures from below freezing up to 800°F. They are available for capacities up to 3200 gal. per min. and in a wide range of material combinations to suit the liquid being pumped. Every practical feature contributing to dependable operation and low maintenance has been incorporated in the design."

A number of cross-sections and photographs clearly show the various features of these pumps as well as the several modifications availa'le. Of further interest is an illustrated discussion of the Cameron Shaft-Seal, which is optional equipment in the place of the conventional stuffingbox to save leakage and reduce maintenance.

(27) *Turbo-blowers*

The A-B C of Allis-Chalmers turbo-blowers, rotary compressors, and vacuum pumps is explained fu'ly in a 16-page booklet designed for student training, which tells what these uni's are, how they operate, and how to figure them. C'everly illustrated, the booklet shows the simple construction of the Allis-Chalmers turbo-blower and tells why it is important that complete information be supplied to figure blowers correctly. Reproduced are curves depicting pressure volume, influence of water vapor on volume and correction curves for volumes to maintain constant air weight with changes in temperature and barometric pressure.

(28) *Pressure pack equipment*

The first of The National Supply Company's new series of "How To" product bulletins, covering the Type "B" pressure pack wellhead equipment, now has been published. In addition to the usual list of specifications and detailed blueprints of the pressure pack equipment the new bulletin features a series of photographs and captions showing how to install the equipment. Nine photographs with captions explain graphically how to install the pressure pack equipment under normal conditions. Eight other photographs and instructions cover installations of the regular safety flange and the cross-over safety flange where added protection or a means for testing is desired.

Simplicity of design is the feature of National's Type "B" pressure pack wellhead equipment. In assembly, parts are self locating and self-activating. No special tools or adjustments are required.

(29) *All-welded clamshell bucket*

Advantages of modern all-welded construction in the design of clamshell buckets are analyzed in a new 8-page booklet in color published by the C. S. Johnson Company, Koehring subsidiary, Champaign, Illinois. Modern all-welded construction is being utilized by C. S. Johnson engineers to increase bucket strength, to improve digging balance and to step up bucket pay-loads.

(30) *Personal safety equipment*

E. D. Bullard Company, manufacturers and distributors of personal safety equipment, have recently issued a catalog and safety manual of postwar items of industrial safety. The 106-page book is divided into seven sections: Eye Protection; Welders' Safety; Gas, Dust and Fume Protection; First Aid; Hats, Belts and Clothing; Miscellaneous Safety Equipment; Lamps and Lanterns. The catalog is now being distributed to major industries.

(31) *"Future with a past"*

The yesterdays of scientists and inventors, who made the world of today one of mechanization and who give such promise to machinery's tomorrow, are chronicled in "A Future With a Past," a new booklet published by Caterpillar Tractor Company, Peoria, Illinois. The profusely illustrated 12-page color publication points to the humble beginnings of the world's heavy work machinery and dramatically portrays the evolution that produced today's economical equipment as a prologue to the developments to be expected of the future.

(32) *Louis Allis motor*

The Louis Allis Company, Milwaukee, Wisconsin, has released a new bulletin, No. 720, covering its Type OG (protected type) standard squirrel cage induction motor. The motor described has been tried and proved in the most critical war jobs during the last few years, it is stated. Bulletin No. 720 covers fully the construction, features, and some typical applications of this motor.

(33) *Bristol tachometers*

The Bristol Company, Waterbury, Connecticut, announces a new bulletin, No. S1400, describing its line of tachometer recorders and indicators. The 12-page bulletin includes a complete description of the Pyromaster potentiometer type tachometer, together with a description of the millivoltmeter-type indicating, and strip-chart recording tachometers. Complete wiring diagrams, application data, and accessory information are given, including illustrations of instruments, magnetos, and a typical installation.

(34) *Magnilastic catalog*

A newly revised and enlarged catalog of its products has been issued by MagniLastic, a division of Cook Electric Company, Chicago, Illinois. The catalog lists complete engineering data, dimensional tables and specifications for MagniLastic's standard packless expansion joints, anchor joints, and low pressure—large diameter expansion joints. It contains information on other recent MagniLastic developments such as offset, turbo and jacket joints, and includes material on high temperature exhaust bellows and heavy duty clinch-lock bellows.

(35) *Protective coating*

A comprehensive 8-page technical bulletin, streamlined for ready reference, gives complete factual information in condensed form about the entire Amercoat line, without embellishment. All industries having corrosion and contamination control problems will appreciate its practical approach to an ever-present problem.

The chart shows all characteristics and properties of Amercoat plastic coatings. Also, it is a ready guide for selecting the proper coating, preparation of the surface, and application methods on steel, concrete, and wood. In addition, cost per square foot for materials, with area formulae, is provided. A copy of this useful chart is available.

(36) *Roof maintenance*

A new, illustrated folder entitled "Hidden Hazards on Your Roof" has been published by the Stonhard Company. Of interest to plant owners and operators, this handy maintenance guide discusses the repair and water-proofing of worn, leaky roofs, and points out the economical way to restore life to cracked or dried out roof surfaces.

(37) *Arc welding manual*

Air Reduction has announced publication of "Manual of Design for Arc Welded Steel Structures," a 300-page definitive work that is said to be the first of its kind. Compiled by LeMotte Grover, M., Am. Soc. C. E., who is widely-recognized in the field of structural welding, this book offers a wealth of useful, up-to-date information covering fundamentals of design, materials, inspection, estimating and engineering control of welding and related operations.

Chapters are included to encompass electrode requirements, specifications for welded connections for all sizes of rolled beams, and a series of diagrams for the rapid design of welded connections.

(38) *Role of the diesel*

A pocket-size booklet "What Do G. M. Diesels Do?" was written in verse form and illustrated by Jim Brown, product news manager of the Detroit Diesel Engine Division of General Motors. It describes the role that compact, high-speed diesels play in the every-day lives of all of us, and illustrates about 40 of these applications. Diesel engine applications were limited to electric power generation, streamlined trains and large boats a few years ago, but they now play a vital part in development of hitherto inaccessible natural resources.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 111

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their tenth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue.

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Pressure of various fluid columns in wells		P 425.250		229	Sept.
Flow curve—bottom hole choke beans		P 511.222		227	Sept.
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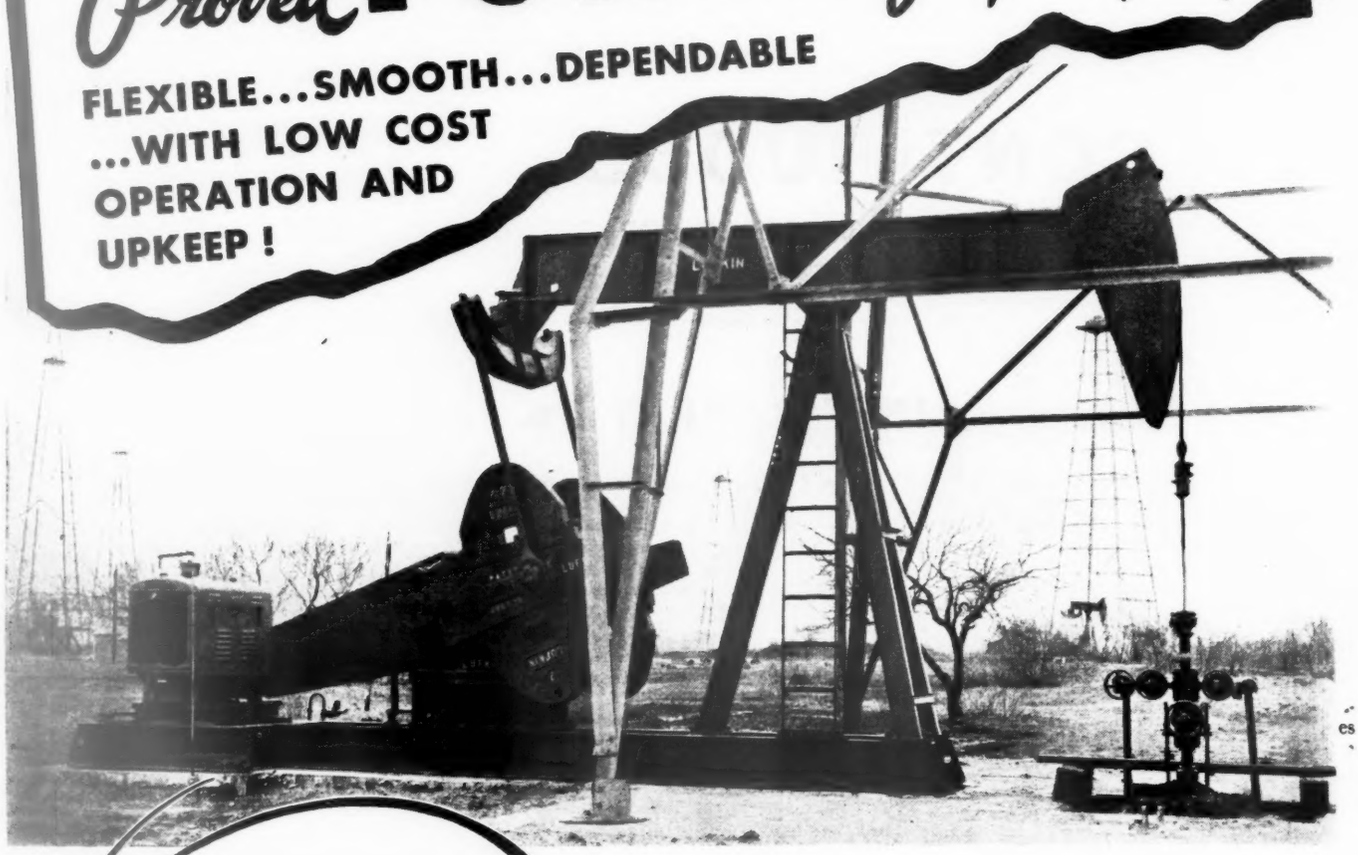
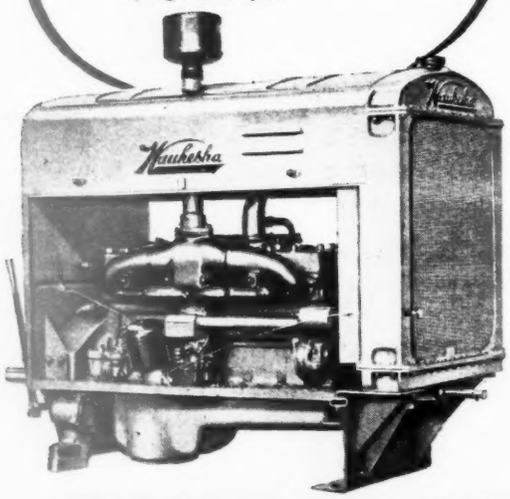
Nash Engineering Co.	(sheet 7)	236	Sept.	P 622.01	
Powell, Wm., Co.	(sheet 6)	234	Sept.	P 622.01	

Proved POWER *for pumping*

FLEXIBLE...SMOOTH...DEPENDABLE ...WITH LOW COST OPERATION AND UPKEEP!



MODEL MZAU WAUKESHA OIL FIELD POWER UNIT—6 cylinders, 4¼ in. x 4¾ in., 404 cu. in. displ. Burning natural gas, develops 72 hp. @ 1600 rpm.



This well in Texas, owned by one of America's leading oil companies, is producing 200 barrels of oil daily. Its pumping unit is Waukesha-powered. The Lufkin TC-2A-35 Pumping Unit . . . with flush type base that clears counterbalance above base beams . . . has a sub-surface equipment of 4500 ft. of ¾ in. rods with a 1½ in. diam. plunger type pump. The rig is pumping eighteen 54-in. strokes per minute, with its 6-MZRU Waukesha Power Unit developing 55 hp. at the pumping speed of 1080 rpm, burning natural gas.

Waukesha *moderate speed* well pumping units combine flexibility of speed range with proved dependability. Fueled with your own product—natural gas—or with butane, gasoline or diesel fuels—Waukeshas give you maximum power output with both fuel and lubricating economy. Servicing is easier *and* upkeep is less. Small foundations keep installation cost low. Lubrication is automatic. Cooling is positive under all duty conditions. Only periodic inspection is necessary. These enclosed weatherproof Waukesha Power Units range from 10 hp. to 210 hp. *Get Bulletin 1270.*

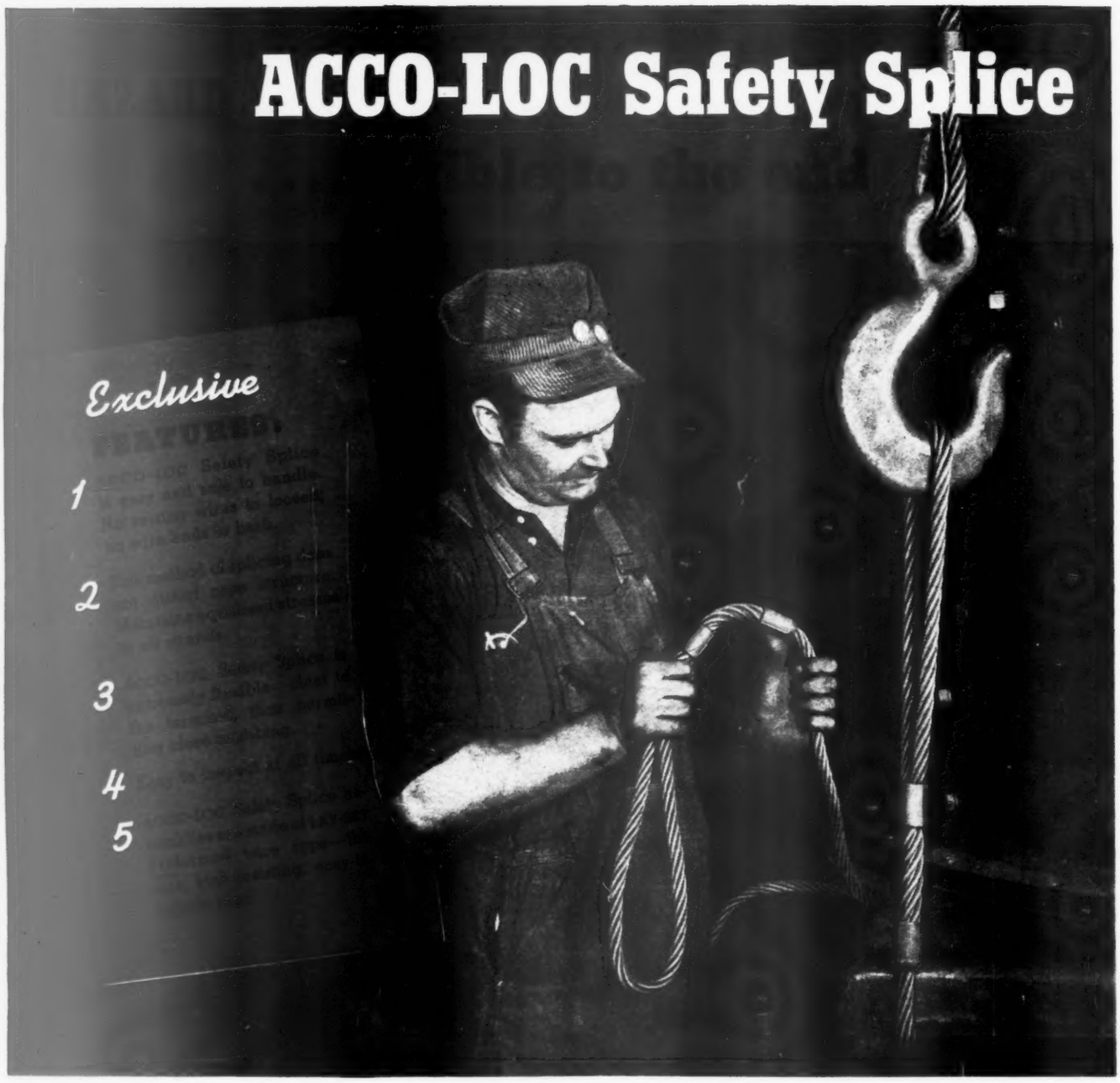
WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

WAUKESHA
OIL FIELD POWER

CAPACITY OF MUD PIT, BBL. (42 GAL.) PER IN. DEPTH

Width, ft., in.	Length, ft. in.																							
	8 0	8 1	8 2	8 3	8 4	8 5	8 6	8 7	8 8	8 9	8 10	8 11	9 0	9 1	9 2	9 3	9 4	9 5	9 6	9 7	9 8	9 9	9 10	9 11
6 0	0.712	0.720	0.727	0.735	0.742	0.750	0.757	0.764	0.772	0.779	0.787	0.794	0.801	0.809	0.816	0.824	0.831	0.839	0.846	0.853	0.861	0.868	0.876	0.883
6 1	0.722	0.730	0.737	0.745	0.752	0.760	0.767	0.775	0.783	0.790	0.798	0.805	0.813	0.820	0.828	0.835	0.843	0.850	0.858	0.865	0.873	0.880	0.888	0.895
6 2	0.732	0.740	0.747	0.755	0.763	0.770	0.778	0.786	0.793	0.801	0.808	0.816	0.824	0.831	0.839	0.847	0.854	0.862	0.870	0.877	0.885	0.892	0.900	0.908
6 3	0.742	0.750	0.758	0.765	0.773	0.781	0.788	0.796	0.804	0.812	0.819	0.827	0.835	0.843	0.850	0.858	0.866	0.874	0.881	0.889	0.897	0.904	0.912	0.920
6 4	0.752	0.760	0.768	0.776	0.783	0.791	0.799	0.807	0.815	0.823	0.830	0.838	0.846	0.854	0.862	0.870	0.877	0.885	0.893	0.901	0.909	0.917	0.924	0.932
6 5	0.762	0.770	0.778	0.786	0.794	0.802	0.810	0.817	0.825	0.833	0.841	0.849	0.857	0.865	0.873	0.881	0.889	0.897	0.905	0.913	0.921	0.929	0.937	0.944
6 6	0.772	0.780	0.788	0.796	0.804	0.812	0.820	0.828	0.836	0.844	0.852	0.860	0.868	0.876	0.884	0.892	0.900	0.908	0.917	0.925	0.933	0.941	0.949	0.957
6 7	0.782	0.790	0.798	0.806	0.814	0.822	0.831	0.839	0.847	0.855	0.863	0.871	0.879	0.888	0.896	0.904	0.912	0.920	0.928	0.936	0.945	0.953	0.961	0.969
6 8	0.792	0.800	0.808	0.816	0.825	0.833	0.841	0.849	0.858	0.866	0.874	0.882	0.891	0.899	0.907	0.915	0.924	0.932	0.940	0.948	0.956	0.965	0.973	0.981
6 9	0.801	0.810	0.818	0.827	0.835	0.843	0.852	0.860	0.868	0.877	0.885	0.893	0.902	0.910	0.918	0.927	0.935	0.943	0.952	0.960	0.968	0.977	0.985	0.993
6 10	0.811	0.820	0.828	0.837	0.845	0.854	0.862	0.871	0.879	0.887	0.896	0.904	0.913	0.921	0.930	0.938	0.947	0.955	0.964	0.972	0.980	0.989	0.997	1.006
6 11	0.821	0.830	0.838	0.847	0.855	0.864	0.873	0.881	0.890	0.898	0.907	0.915	0.924	0.932	0.941	0.950	0.958	0.967	0.975	0.984	0.992	1.001	1.009	1.018
7 0	0.831	0.840	0.848	0.857	0.866	0.874	0.883	0.892	0.900	0.909	0.918	0.926	0.935	0.944	0.952	0.961	0.970	0.978	0.987	0.996	1.004	1.013	1.022	1.030
7 1	0.841	0.850	0.858	0.867	0.876	0.885	0.894	0.902	0.910	0.920	0.929	0.937	0.946	0.955	0.964	0.972	0.981	0.990	0.999	1.008	1.016	1.025	1.034	1.043
7 2	0.851	0.860	0.869	0.878	0.886	0.895	0.904	0.913	0.922	0.931	0.940	0.948	0.957	0.966	0.975	0.984	0.993	1.002	1.011	1.019	1.028	1.037	1.046	1.055
7 3	0.861	0.870	0.879	0.888	0.897	0.906	0.915	0.924	0.933	0.942	0.951	0.959	0.968	0.977	0.986	0.995	1.004	1.013	1.022	1.031	1.040	1.049	1.058	1.067
7 4	0.871	0.880	0.889	0.898	0.907	0.916	0.925	0.934	0.943	0.952	0.961	0.971	0.980	0.989	0.998	1.007	1.016	1.025	1.034	1.043	1.052	1.061	1.070	1.079
7 5	0.881	0.890	0.899	0.908	0.917	0.927	0.936	0.945	0.954	0.963	0.972	0.982	0.991	1.000	1.009	1.018	1.027	1.037	1.046	1.055	1.064	1.073	1.082	1.092
7 6	0.891	0.900	0.909	0.918	0.928	0.937	0.946	0.955	0.965	0.974	0.983	0.993	1.002	1.012	1.020	1.030	1.039	1.048	1.058	1.067	1.076	1.085	1.095	1.104
7 7	0.900	0.910	0.919	0.928	0.938	0.947	0.957	0.966	0.975	0.985	0.994	1.004	1.013	1.022	1.032	1.041	1.051	1.060	1.069	1.079	1.088	1.097	1.107	1.116
7 8	0.910	0.920	0.929	0.939	0.948	0.958	0.967	0.977	0.986	0.996	1.005	1.015	1.024	1.034	1.043	1.053	1.062	1.072	1.081	1.090	1.100	1.109	1.119	1.128
7 9	0.920	0.930	0.939	0.949	0.958	0.968	0.978	0.987	0.997	1.006	1.016	1.026	1.035	1.045	1.054	1.064	1.074	1.083	1.093	1.102	1.112	1.121	1.131	1.141
7 10	0.930	0.940	0.949	0.959	0.969	0.979	0.988	0.998	1.008	1.017	1.027	1.037	1.046	1.056	1.066	1.075	1.085	1.095	1.105	1.114	1.124	1.134	1.143	1.153
7 11	0.940	0.950	0.960	0.969	0.979	0.989	0.999	1.009	1.018	1.028	1.038	1.048	1.058	1.068	1.077	1.087	1.097	1.106	1.116	1.126	1.136	1.146	1.155	1.165
8 0	0.950	0.960	0.970	0.979	0.989	0.999	1.009	1.019	1.029	1.039	1.049	1.059	1.069	1.079	1.088	1.098	1.108	1.118	1.128	1.138	1.148	1.158	1.168	1.177
8 1	0.960	0.970	0.980	0.990	1.000	1.010	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.100	1.110	1.120	1.130	1.140	1.150	1.160	1.170	1.180	1.190
8 2	0.970	0.980	0.990	1.000	1.010	1.020	1.030	1.040	1.051	1.061	1.171	1.081	1.091	1.101	1.111	1.121	1.131	1.141	1.152	1.162	1.172	1.182	1.192	1.202
8 3	0.980	0.990	1.000	1.010	1.020	1.031	1.041	1.051	1.061	1.071	1.082	1.092	1.102	1.112	1.122	1.133	1.143	1.153	1.163	1.173	1.184	1.194	1.204	1.214
8 4	0.989	1.000	1.010	1.020	1.031	1.041	1.051	1.062	1.072	1.082	1.093	1.103	1.113	1.123	1.134	1.144	1.154	1.165	1.175	1.185	1.196	1.206	1.216	1.227
8 5	0.999	1.010	1.020	1.031	1.041	1.051	1.062	1.072	1.083	1.093	1.103	1.114	1.124	1.135	1.145	1.156	1.166	1.176	1.187	1.197	1.208	1.218	1.228	1.239
8 6	1.009	1.020	1.030	1.041	1.051	1.062	1.072	1.083	1.093	1.104	1.114	1.125	1.135	1.146	1.156	1.167	1.177	1.188	1.199	1.209	1.220	1.230	1.241	1.251
8 7	1.019	1.030	1.040	1.051	1.062	1.072	1.083	1.093	1.104	1.115	1.125	1.136	1.147	1.157	1.168	1.178	1.189	1.200	1.210	1.221	1.231	1.242	1.253	1.263
8 8	1.029	1.040	1.050	1.061	1.072	1.083	1.093	1.104	1.115	1.126	1.136	1.147	1.158	1.168	1.179	1.190	1.201	1.211	1.222	1.233	1.243	1.254	1.265	1.276
8 9	1.039	1.050	1.061	1.071	1.082	1.093	1.104	1.115	1.126	1.136	1.147	1.158	1.169	1.180	1.190	1.201	1.212	1.223	1.234	1.245	1.255	1.266	1.277	1.288
8 10	1.049	1.060	1.071	1.082	1.093	1.103	1.114	1.125	1.136	1.147	1.158	1.169	1.180	1.191	1.202	1.213	1.224	1.235	1.246	1.256	1.267	1.278	1.289	1.300
8 11	1.059	1.070	1.081	1.092	1.103	1.114	1.125	1.136	1.147	1.158	1.169	1.180	1.191	1.202	1.213	1.224	1.235	1.246	1.257	1.268	1.279	1.290	1.301	1.312
9 0	1.069	1.080	1.091	1.102	1.113	1.124	1.135	1.146	1.158	1.169	1.180	1.191	1.202	1.213	1.224	1.236	1.247	1.258	1.269	1.280	1.291	1.302	1.314	1.325
9 1	1.079	1.090	1.101	1.112	1.123	1.135	1.146	1.157	1.168	1.180	1.191	1.202	1.213	1.224	1.236	1.247	1.258	1.270	1.281	1.292	1.303	1.314	1.326	1.337
9 2	1.088	1.100	1.111	1.122	1.134	1.145	1.156	1.168	1.179	1.190	1.202	1.213	1.224	1.236	1.247	1.258	1.270	1.281	1.293	1.304	1.315	1.327	1.338	1.349
9 3	1.098	1.110	1.121	1.133	1.144	1.156	1.167	1.178	1.190	1.201	1.213	1.224	1.236	1.247	1.258	1.270	1.281	1.293	1.304	1.316	1.327	1.339	1.350	1.361
9 4	1.108	1.120	1.131	1.143	1.154	1.165	1.177	1.189	1.200	1.212	1.224	1.235	1.247	1.258	1.270	1.281	1.293	1.304	1.316	1.328	1.339	1.351	1.362	1.374
9 5	1.118	1.130	1.141	1.153	1.165	1.176	1.188	1.200	1.211	1.223	1.235	1.245	1.258	1.270	1.281	1.293	1.304	1.316	1.328	1.339	1.351	1.363	1.374	1.386
9 6	1.128	1.140	1.152	1.163	1.175	1.187	1.199	1.210	1.222	1.234	1.246	1.257	1.269	1.281	1.293	1.304	1.316	1.328	1.339	1.351	1.363	1.375	1.387	1.398
9 7	1.138	1.150	1.162	1.173	1.185	1.197	1.209	1.221	1.233	1.245	1.256	1.268	1.280	1.292	1.304	1.316	1.328	1.339	1.351	1.363	1.375	1.387	1.399	1.411
9 8	1.148	1.160	1.172	1.184	1.196	1.208	1.219	1.231	1.243	1.255	1.267	1.279	1.291	1.303	1.315	1.327	1.339	1.351	1.363	1.375	1.387	1.399	1.411	1.423
9 9	1.158	1.170	1.182	1.194	1.206	1.218	1.230	1.242	1.254	1.266	1.278	1.290	1.302	1.314	1.327	1.339	1.351	1.363	1.375	1.387	1.399	1.411	1.423	1.435
9 10	1.168	1.180	1.192	1.204	1.216	1.228	1.241	1.253	1.265	1.277	1.289	1.301	1.314	1.326	1.338	1.350	1.362	1.374	1.386	1.399	1.411	1.423	1.435	1.447
9 11	1.177	1.190	1.202	1.214	1.227	1.239	1.251	1.263	1.276	1.288	1.300	1.312	1.325	1.337	1.349	1.361	1.374	1.386	1.398	1.411	1.423	1.435	1.447	1.460

ACCO-LOC Safety Splice



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Width, ft., in.	Length, ft. in.																							
	10 0	10 1	10 2	10 3	10 4	10 5	10 6	10 7	10 8	10 9	10 10	10 11	11 0	11 1	11 2	11 3	11 4	11 5	11 6	11 7	11 8	11 9	11 10	11 11
6 0	0.891	0.898	0.905	0.913	0.920	0.928	0.935	0.942	0.950	0.957	0.965	0.972	0.980	0.987	0.994	1.002	1.009	1.017	1.024	1.032	1.039	1.046	1.054	1.061
6 1	0.903	0.910	0.918	0.925	0.933	0.941	0.948	0.956	0.963	0.971	0.978	0.986	0.993	1.001	1.008	1.016	1.023	1.031	1.038	1.046	1.053	1.061	1.068	1.076
6 2	0.915	0.923	0.931	0.938	0.946	0.953	0.961	0.969	0.976	0.984	0.992	0.999	1.007	1.014	1.022	1.030	1.037	1.045	1.053	1.060	1.068	1.075	1.083	1.091
6 3	0.928	0.935	0.943	0.951	0.959	0.966	0.974	0.982	0.989	0.997	1.005	1.013	1.020	1.028	1.036	1.044	1.051	1.059	1.067	1.075	1.082	1.090	1.098	1.105
6 4	0.940	0.948	0.956	0.964	0.971	0.979	0.987	0.995	1.003	1.011	1.018	1.026	1.034	1.042	1.050	1.058	1.065	1.073	1.081	1.089	1.097	1.105	1.112	1.120
6 5	0.952	0.960	0.968	0.976	0.984	0.992	1.000	1.008	1.016	1.024	1.032	1.040	1.048	1.056	1.063	1.071	1.079	1.087	1.095	1.103	1.111	1.119	1.127	1.135
6 6	0.965	0.973	0.981	0.989	0.997	1.005	1.013	1.021	1.029	1.037	1.045	1.053	1.061	1.069	1.077	1.085	1.093	1.101	1.109	1.117	1.126	1.134	1.142	1.150
6 7	0.977	0.985	0.993	1.002	1.010	1.018	1.026	1.034	1.042	1.050	1.059	1.067	10.75	1.083	1.091	1.099	1.107	1.116	1.124	1.132	1.140	1.148	1.156	1.164
6 8	0.989	0.998	1.006	1.014	1.022	1.031	1.039	1.047	1.055	1.064	1.072	1.080	1.088	1.097	1.105	1.113	1.121	1.130	1.138	1.146	1.154	1.163	1.171	1.179
6 9	1.002	1.010	1.019	1.027	1.035	1.044	1.052	1.060	1.069	1.077	1.085	1.094	1.102	1.110	1.119	1.127	1.135	1.144	1.152	1.160	1.169	1.177	1.186	1.194
6 10	1.014	1.023	1.031	1.040	1.048	1.056	1.065	1.073	1.082	1.090	1.099	1.107	1.116	1.124	1.133	1.141	1.149	1.158	1.166	1.175	1.183	1.192	1.200	1.209
6 11	1.027	1.035	1.044	1.052	1.061	1.069	1.078	1.086	1.095	1.104	1.112	1.121	1.129	1.138	1.146	1.155	1.163	1.172	1.181	1.189	1.198	1.206	1.215	1.223
7 0	1.039	1.047	1.056	1.065	1.074	1.082	1.091	1.099	1.108	1.117	1.126	1.134	1.143	1.152	1.160	1.169	1.177	1.186	1.195	1.203	1.212	1.221	1.229	1.238
7 1	1.051	1.060	1.069	1.078	1.086	1.095	1.104	1.113	1.121	1.130	1.139	1.148	1.156	1.165	1.174	1.183	1.191	1.200	1.209	1.218	1.227	1.235	1.244	1.253
7 2	1.064	1.073	1.081	1.090	1.099	1.108	1.117	1.126	1.135	1.143	1.152	1.161	1.170	1.179	1.188	1.197	1.206	1.214	1.223	1.232	1.241	1.250	1.259	1.268
7 3	1.076	1.085	1.094	1.103	1.112	1.121	1.130	1.139	1.148	1.157	1.166	1.175	1.184	1.193	1.202	1.211	1.220	1.229	1.237	1.246	1.255	1.264	1.273	1.282
7 4	1.088	1.098	1.107	1.116	1.125	1.134	1.143	1.152	1.161	1.170	1.179	1.188	1.197	1.206	1.215	1.224	1.234	1.243	1.252	1.261	1.270	1.279	1.288	1.297
7 5	1.101	1.110	1.119	1.128	1.137	1.147	1.156	1.165	1.174	1.183	1.193	1.202	1.211	1.220	1.229	1.238	1.248	1.257	1.266	1.275	1.284	1.293	1.303	1.312
7 6	1.113	1.122	1.132	1.141	1.150	1.160	1.169	1.178	1.187	1.197	1.206	1.215	1.224	1.234	1.243	1.252	1.262	1.271	1.280	1.289	1.299	1.308	1.317	1.327
7 7	1.126	1.135	1.144	1.154	1.163	1.172	1.182	1.191	1.201	1.210	1.219	1.229	1.238	1.247	1.257	1.266	1.276	1.285	1.294	1.304	1.313	1.323	1.332	1.341
7 8	1.138	1.147	1.157	1.166	1.176	1.185	1.195	1.204	1.214	1.223	1.233	1.242	1.252	1.261	1.271	1.280	1.290	1.299	1.309	1.318	1.328	1.337	1.347	1.356
7 9	1.150	1.160	1.169	1.179	1.189	1.198	1.208	1.217	1.227	1.237	1.246	1.256	1.265	1.275	1.284	1.294	1.304	1.313	1.323	1.332	1.342	1.352	1.361	1.371
7 10	1.163	1.172	1.182	1.192	1.201	1.211	1.221	1.230	1.240	1.250	1.260	1.269	1.279	1.289	1.298	1.308	1.318	1.327	1.337	1.347	1.356	1.366	1.376	1.385
7 11	1.175	1.185	1.195	1.204	1.214	1.224	1.234	1.244	1.253	1.263	1.273	1.283	1.293	1.302	1.312	1.322	1.332	1.341	1.351	1.361	1.371	1.381	1.390	1.400
8 0	1.187	1.197	1.207	1.217	1.227	1.237	1.247	1.257	1.167	1.276	1.286	1.296	1.306	1.316	1.326	1.336	1.346	1.356	1.365	1.375	1.385	1.395	1.405	1.415
8 1	1.200	1.210	1.220	1.230	1.240	1.250	1.260	1.270	1.280	1.290	1.300	1.310	1.320	1.330	1.340	1.350	1.360	1.370	1.380	1.390	1.400	1.410	1.420	1.430
8 2	1.212	1.222	1.232	1.242	1.252	1.263	1.273	1.283	1.293	1.303	1.313	1.323	1.333	1.343	1.354	1.364	1.374	1.384	1.394	1.404	1.414	1.424	1.434	1.444
8 3	1.224	1.235	1.245	1.255	1.265	1.276	1.286	1.296	1.306	1.316	1.327	1.337	1.347	1.357	1.367	1.378	1.388	1.398	1.408	1.418	1.429	1.439	1.449	1.459
8 4	1.237	1.247	1.257	1.268	1.278	1.288	1.299	1.309	1.319	1.330	1.340	1.350	1.361	1.371	1.381	1.391	1.402	1.412	1.422	1.433	1.443	1.453	1.464	1.474
8 5	1.249	1.260	1.270	1.280	1.291	1.301	1.312	1.322	1.332	1.343	1.353	1.364	1.374	1.385	1.395	1.405	1.416	1.426	1.437	1.447	1.457	1.468	1.478	1.489
8 6	1.262	1.272	1.283	1.293	1.304	1.314	1.325	1.335	1.346	1.356	1.367	1.377	1.388	1.398	1.409	1.419	1.430	1.440	1.451	1.461	1.472	1.482	1.493	1.503
8 7	1.274	1.284	1.295	1.306	1.316	1.327	1.338	1.348	1.359	1.370	1.380	1.391	1.401	1.412	1.423	1.433	1.444	1.454	1.465	1.476	1.486	1.497	1.508	1.518
8 8	1.286	1.297	1.308	1.318	1.329	1.340	1.351	1.361	1.372	1.383	1.393	1.404	1.415	1.426	1.436	1.447	1.458	1.469	1.479	1.490	1.501	1.511	1.522	1.533
8 9	1.299	1.309	1.320	1.330	1.342	1.353	1.364	1.374	1.385	1.396	1.407	1.418	1.429	1.439	1.450	1.461	1.472	1.483	1.493	1.504	1.515	1.526	1.537	1.548
8 10	1.311	1.322	1.333	1.344	1.355	1.366	1.377	1.388	1.398	1.409	1.420	1.431	1.442	1.453	1.464	1.475	1.486	1.497	1.508	1.519	1.530	1.541	1.551	1.562
8 11	1.323	1.334	1.345	1.357	1.368	1.379	1.390	1.400	1.412	1.423	1.434	1.445	1.456	1.467	1.478	1.489	1.500	1.511	1.522	1.533	1.544	1.555	1.566	1.577
9 0	1.336	1.347	1.358	1.369	1.380	1.391	1.402	1.414	1.425	1.436	1.447	1.458	1.469	1.481	1.492	1.503	1.514	1.525	1.536	1.547	1.558	1.570	1.581	1.592
9 1	1.348	1.359	1.371	1.382	1.393	1.404	1.416	1.427	1.438	1.449	1.461	1.472	1.483	1.494	1.505	1.517	1.528	1.539	1.550	1.562	1.573	1.584	1.595	1.607
9 2	1.361	1.372	1.383	1.394	1.406	1.417	1.429	1.440	1.451	1.463	1.474	1.485	1.497	1.508	1.519	1.531	1.542	1.553	1.565	1.576	1.587	1.599	1.610	1.621
9 3	1.373	1.384	1.396	1.407	1.419	1.430	1.442	1.453	1.464	1.476	1.487	1.499	1.510	1.522	1.533	1.545	1.556	1.567	1.579	1.590	1.602	1.613	1.625	1.636
9 4	1.385	1.397	1.408	1.420	1.431	1.443	1.455	1.466	1.478	1.489	1.501	1.512	1.524	1.535	1.547	1.558	1.570	1.582	1.593	1.605	1.616	1.628	1.639	1.651
9 5	1.398	1.409	1.421	1.432	1.444	1.456	1.468	1.479	1.491	1.502	1.514	1.526	1.537	1.549	1.561	1.572	1.584	1.596	1.607	1.619	1.631	1.642	1.654	1.666
9 6	1.410	1.422	1.433	1.445	1.457	1.469	1.480	1.492	1.504	1.516	1.528	1.539	1.551	1.563	1.575	1.586	1.598	1.610	1.622	1.633	1.645	1.657	1.669	1.680
9 7	1.422	1.434	1.446	1.458	1.470	1.482	1.493	1.505	1.517	1.529	1.541	1.553	1.565	1.576	1.588	1.600	1.612	1.624	1.636	1.648	1.659	1.671	1.683	1.695
9 8	1.435	1.447	1.459	1.471	1.483	1.494	1.506	1.518	1.530	1.542	1.554	1.565	1.578	1.590	1.602	1.614	1.626	1.638	1.650	1.662	1.674	1.686	1.698	1.710
9 9	1.447	1.459	1.471	1.483	1.495	1.507	1.519	1.532	1.544	1.556	1.568	1.580	1.592	1.604	1.616	1.628	1.640	1.652	1.664	1.676	1.688	1.700	1.712	1.724
9 10	1.459	1.472	1.484	1.496	1.508	1.520	1.532	1.545	1.557	1.569	1.581	1.593	1.605	1.618	1.630	1.642	1.654	1.666	1.678	1.690	1.703	1.715	1.727	1.739
9 11	1.472	1.484	1.496	1.509	1.521	1.533	1.545	1.558	1.571	1.582	1.594	1.607	1.619	1.631	1.644	1.656	1.668	1.680	1.693	1.705	1.717	1.729	1.742	1.754

Does LINK-BELT make ball bearings?

YES [X] NO [ ]

Does LINK-BELT make roller bearings?

YES [X] NO [ ]

Does LINK-BELT make mounted bearings?

YES [X] NO [ ]

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→ look to LINK-BELT for bearing service

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LINK-BELT COMPANY
Indianapolis 6, Dallas 1, Houston 2,
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10,222-A

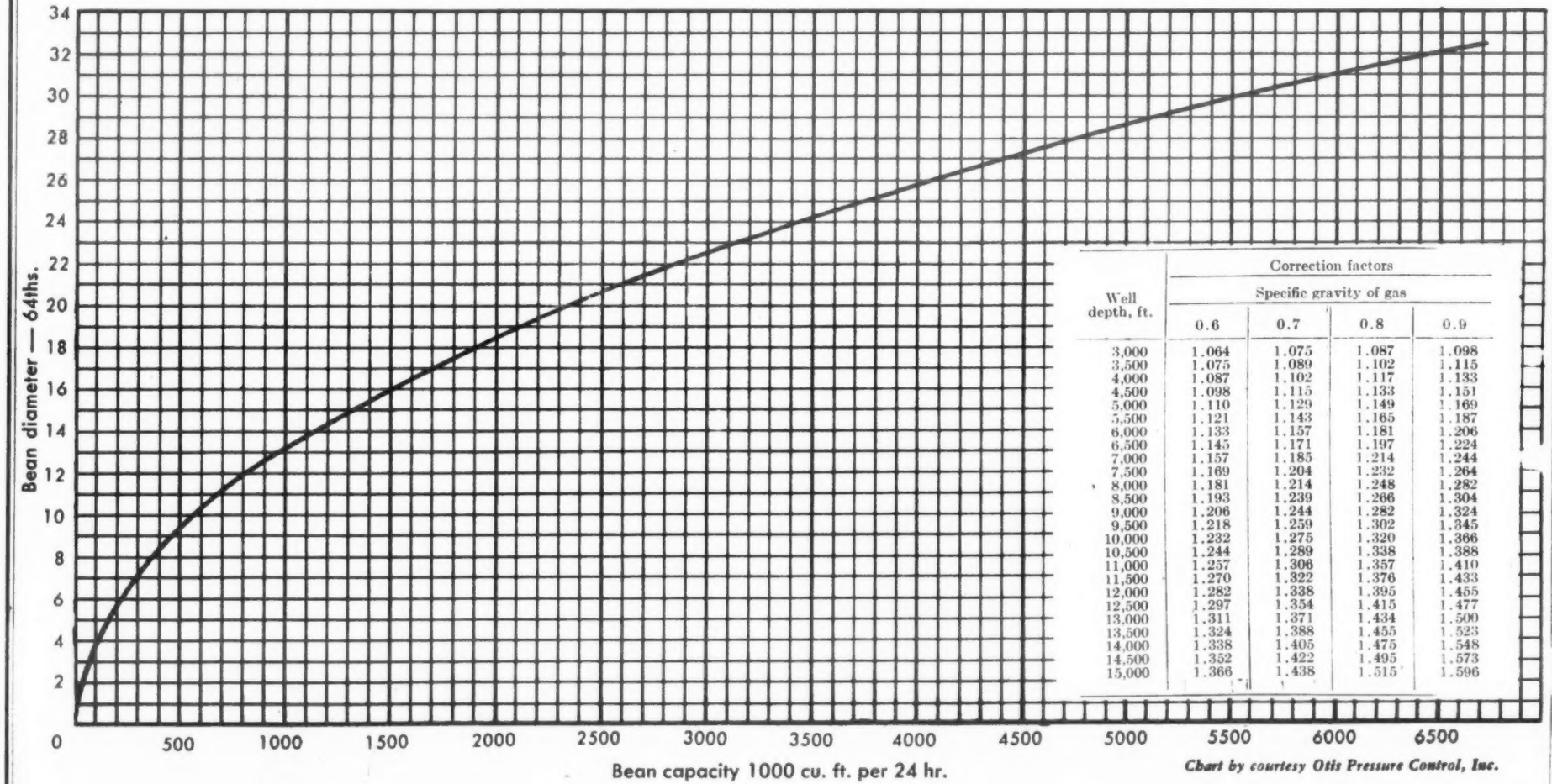
FLOW CURVE — BOTTOM HOLE CHOKE BEANS

To find the bottom hole pressure, multiply the surface pressure by the correction factor corresponding to the well depth and gravity of the gas.

In preparing the corrections average surface readings from 500 lb. to 4000 lb. per sq. in. were used. Using Bureau of Mines Monograph 7 meant extending the tables for both depth and pressure.

Curve is based on conditions where ratio of tubing pressure above bean to pressure below is less than 0.5, assuming 1000 lb. per sq. in. as lower pressure on this curve.

*This table replaces table P 511.22 published in May, 1944.



Well depth, ft.	Correction factors — Specific gravity of gas			
	0.6	0.7	0.8	0.9
3,000	1.064	1.075	1.087	1.098
3,500	1.075	1.089	1.102	1.115
4,000	1.087	1.102	1.117	1.133
4,500	1.098	1.115	1.133	1.151
5,000	1.110	1.129	1.149	1.169
5,500	1.121	1.143	1.165	1.187
6,000	1.133	1.157	1.181	1.206
6,500	1.145	1.171	1.197	1.224
7,000	1.157	1.185	1.214	1.244
7,500	1.169	1.204	1.232	1.264
8,000	1.181	1.214	1.248	1.282
8,500	1.193	1.239	1.266	1.304
9,000	1.206	1.244	1.282	1.324
9,500	1.218	1.259	1.302	1.345
10,000	1.232	1.275	1.320	1.366
10,500	1.244	1.289	1.338	1.388
11,000	1.257	1.306	1.357	1.410
11,500	1.270	1.322	1.376	1.433
12,000	1.282	1.338	1.395	1.455
12,500	1.297	1.354	1.415	1.477
13,000	1.311	1.371	1.434	1.500
13,500	1.324	1.388	1.455	1.523
14,000	1.338	1.405	1.475	1.548
14,500	1.352	1.422	1.495	1.573
15,000	1.366	1.438	1.515	1.596

Chart by courtesy Otis Pressure Control, Inc.

Exhaust steam condensing
Engine jacket water cooling
Engine oil cooling
Gas compressor aftercooling
Process gas cooling
Solution cooling
Quenching oil cooling
Still reflux condensing
Final overhead condensing
Refrigeration system condensing
Gas treating and purification system condensing and cooling

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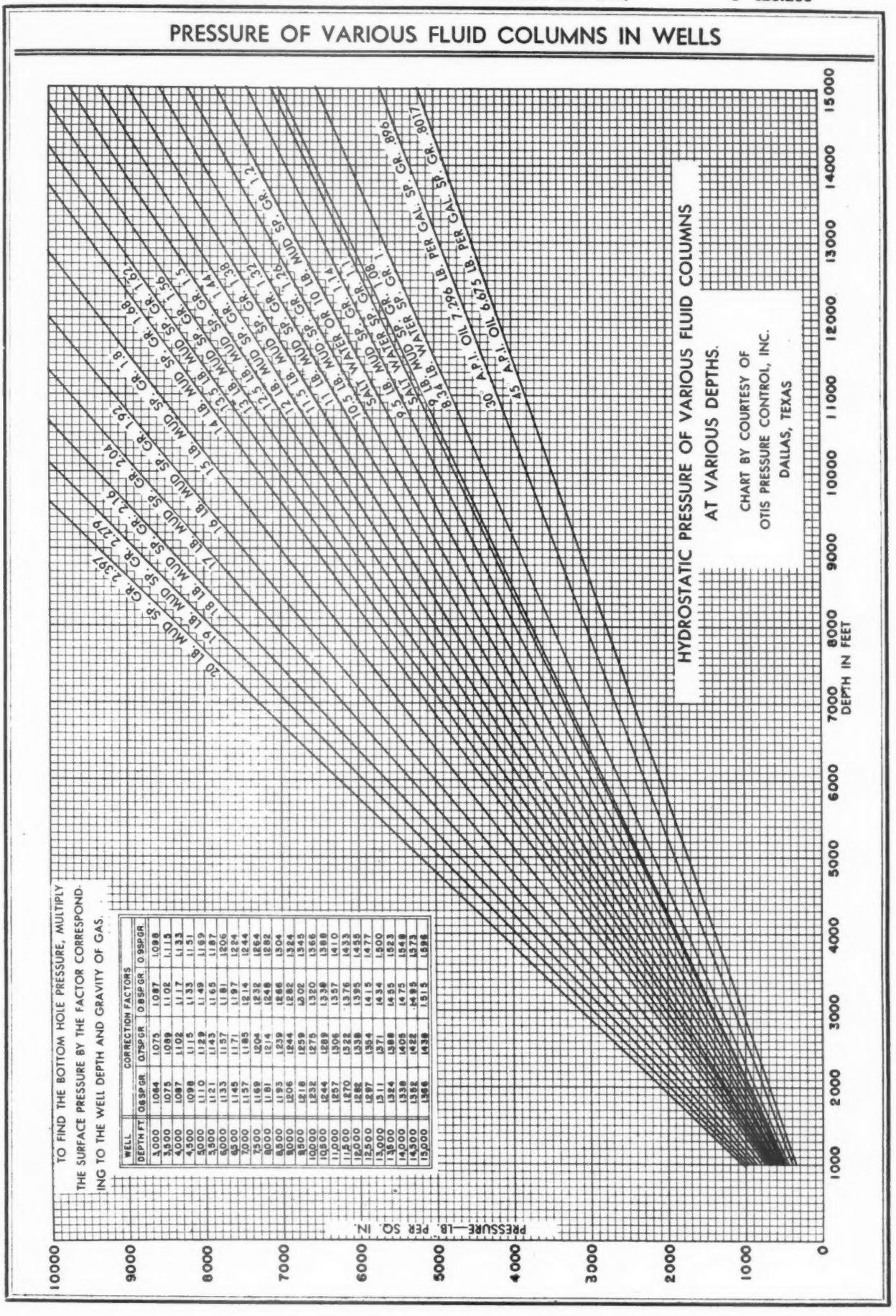
PRESSURE OF VARIOUS FLUID COLUMNS IN WELLS


HYDROSTATIC PRESSURE OF VARIOUS FLUID COLUMNS AT VARIOUS DEPTHS.
CHART BY COURTESY OF OTIS PRESSURE CONTROL, INC. DALLAS, TEXAS
DEPTH IN FEET
PRESSURE—LB. PER SQ. IN.
45 A.P.I. OIL 6.675 LB. PER GAL. SP. GR. .8017
30 A.P.I. OIL 7.296 LB. PER GAL. SP. GR. .8906
8.34 LB. WATER SP. GR. 1
9.5 LB. SALT MUD SP. GR. 1.08
10.5 LB. SALT MUD SP. GR. 1.17
11 LB. MUD SP. GR. 1.2
11.5 LB. MUD SP. GR. 1.25
12 LB. MUD SP. GR. 1.29
12.5 LB. MUD SP. GR. 1.32
13 LB. MUD SP. GR. 1.36
14 LB. MUD SP. GR. 1.5
15 LB. MUD SP. GR. 1.62
16 LB. MUD SP. GR. 1.72
17 LB. MUD SP. GR. 1.83
18 LB. MUD SP. GR. 1.92
19 LB. MUD SP. GR. 2.04
20 LB. MUD SP. GR. 2.16
2.279
2.397

TO FIND THE BOTTOM HOLE PRESSURE, MULTIPLY THE SURFACE PRESSURE BY THE FACTOR CORRESPONDING TO THE WELL DEPTH AND GRAVITY OF GAS.

WELL DEPTH FT	CORRECTION FACTORS 0.65 SP GR	0.75 SP GR	0.85 SP GR	0.95 SP GR
3,000	1.064	1.075	1.087	1.098
3,500	1.075	1.089	1.102	1.115
4,000	1.087	1.102	1.117	1.133
4,500	1.098	1.115	1.133	1.151
5,000	1.110	1.129	1.149	1.169
5,500	1.121	1.145	1.165	1.187
6,000	1.133	1.157	1.181	1.206
6,500	1.145	1.171	1.197	1.224
7,000	1.157	1.185	1.214	1.244
7,500	1.169	1.204	1.232	1.264
8,000	1.181	1.214	1.248	1.282
8,500	1.193	1.239	1.266	1.304
9,000	1.206	1.244	1.282	1.324
9,500	1.218	1.259	1.302	1.345
10,000	1.232	1.275	1.320	1.366
10,500	1.244	1.289	1.338	1.388
11,000	1.257	1.306	1.357	1.410
11,500	1.270	1.322	1.376	1.433
12,000	1.282	1.338	1.395	1.455
12,500	1.297	1.354	1.415	1.477
13,000	1.311	1.371	1.434	1.500
13,500	1.324	1.388	1.455	1.523
14,000	1.338	1.405	1.475	1.548
14,500	1.352	1.422	1.495	1.573
15,000	1.366	1.438	1.515	1.598

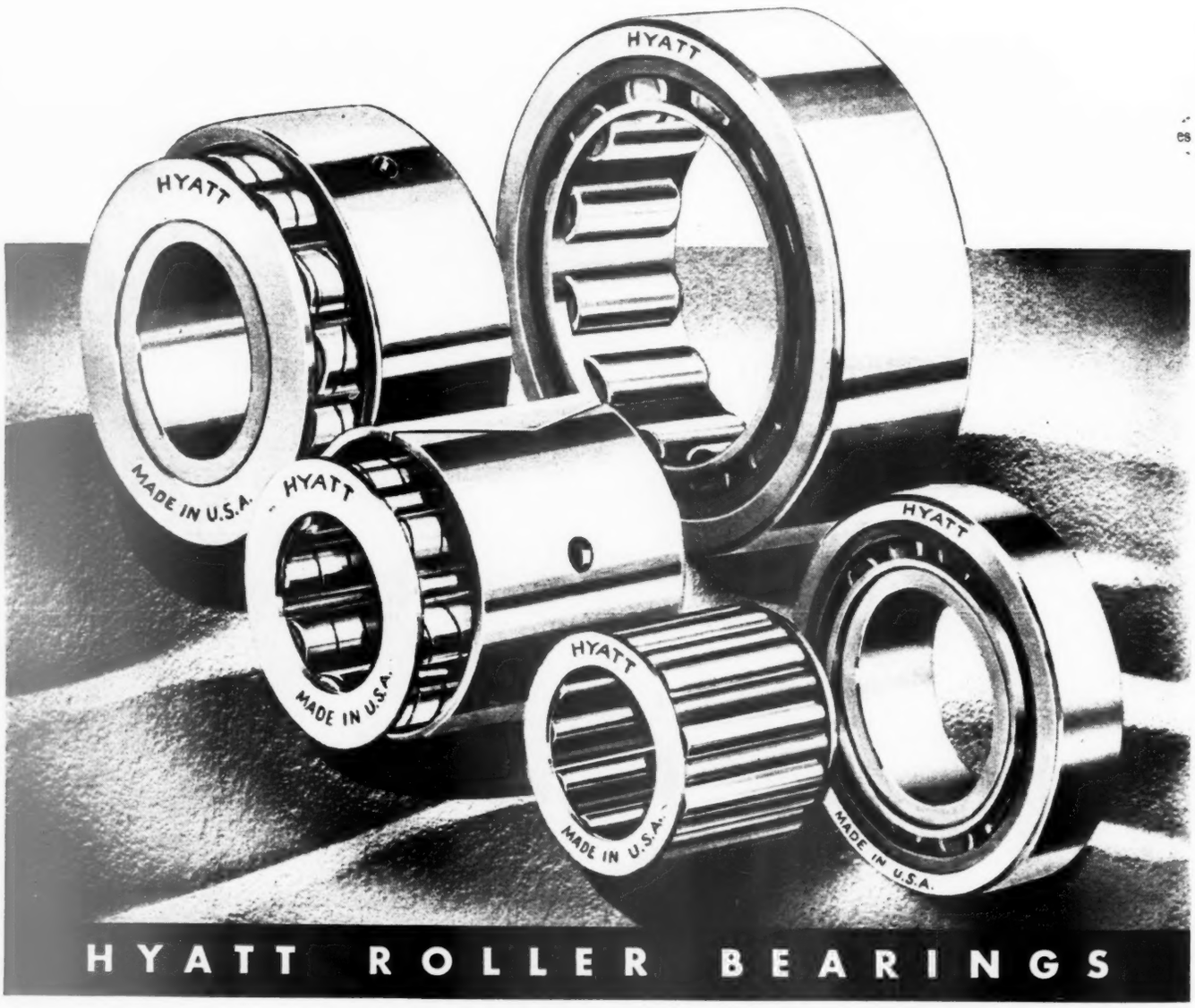
QUOTE—
"HYATT EQUIPPED"

A standard phrase that answers bearing questions in the affirmative.

Leading manufacturers of machines and equipment covering diversified fields quote "Hyatt-Equipped" when they refer to bearing specifications.

Hyatt originated the roller bearing and Hyatt has continued to keep ahead so that it can be truly said—"There is a Hyatt Roller Bearing for every application."

Specializing in roller bearings for fifty-four years, Hyatt engineers have the answers. So put your bearing questions up to them. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT ROLLER BEARINGS

GAS PIPE LINE DESIGN FACTORS

These factors and curves are taken from the article entitled "Solving Problems of Gas Pipe Line Design by Use of Significant Factors," by C. L. Brockschmidt and M. K. Hager that was published in *The Petroleum Engineer* in December, 1944, pages 142 to 164, inclusive.

APPENDIX I

Notation

Symbol *Definition and units*

A. Cross-sectional area of pipe, sq. ft.

a. Fuel gas consumed per hp., per 24 hr., million cu. ft. at P_o and T_o.

b. Compressor hp. required per million cu. ft. pumped per 24 hr.

D. Inside diameter of pipe, ft.

d. Inside diameter of pipe, in.

E. Pipe line experience factor, a decimal fraction expressing the ratio of the flow obtainable in actual practice to the theoretical flow in smooth pipe according to Nikuradse.

f. Coefficient of friction in the general flow formula, no units.

f_L. Length factor used in pipe line solutions, Appendix V.

f_P. Pipe factor used in pipe line solutions, Appendix V.

f_S. Station factor used in pipe line solutions, Appendix V.

f_H. Horsepower factor used in pipe line solutions, Appendix V.

$f_{SH} = f_S \times f_H$. A mathematical operative, Appendix V.

$F_1, F_2 \ldots F_{n-1}$. Fuel gas consumed at station 1, 2 . . . n per 24 hr., million cu. ft.

$F_t = F_1 + F_2 \ldots + F_{n-1}$. Total fuel gas consumed in all stations (except the field station) per 24 hr., million cu. ft.

ϕ. Design factor of safety.

G. Specific gravity of gas, referred to air.

$H_1, H_2 \ldots H_{n-1}$. Compressor hp. at stations 1, 2 . . . (n — 1).

$H_t = H_1 + H_2 \ldots + T_{n-1}$. Total compressor hp. in all stations (except the field station).

k, k_1. Constant in the general flow equation.

K. Constant used in Appendix IV.

L. Length of pipe line (between stations), miles.

$L_1, L_2 \ldots L_n$. Lengths of pipe line sections 1, 2 . . . n, miles.

$L_t = L_1 + L_2 \ldots + L_n$. Total length of pipe line, miles.

n. Number of pipe line sections (between stations).

n—1. Number of compressor stations (excluding the field stations).

P_o. Pressure base, lb. per sq. in. abs.

P_1. Inlet (or station discharge) pressure, lb. per sq. in. abs.

P_2. Outlet (or station suction) pressure, lb. per sq. in. abs.

Q. Volume flowing per 24 hr., cu. ft. at P_o and T_o.

$Q_1, Q_2 \ldots Q_n$. Volume flowing in pipe line sections 1, 2 . . . n per 24 hr., million cu. ft. at P_o and T_o.

$r = P_1 \div P_2$. Compression ratio.

R_e. Reynold's Number, no units.

S. Density of gas, lb. per cu. ft. at P_s and T_s.

s. Ultimate fiber stress of pipe, lb. per sq. in.

t. Thickness of pipe wall, in.

T_o. Temperature base, °F. abs.

T_f. Flowing temperature of gas, °F. abs.

U. Velocity of flowing gas, ft. per sec.

Z. Absolute viscosity of gas, lb. per sec. per ft.

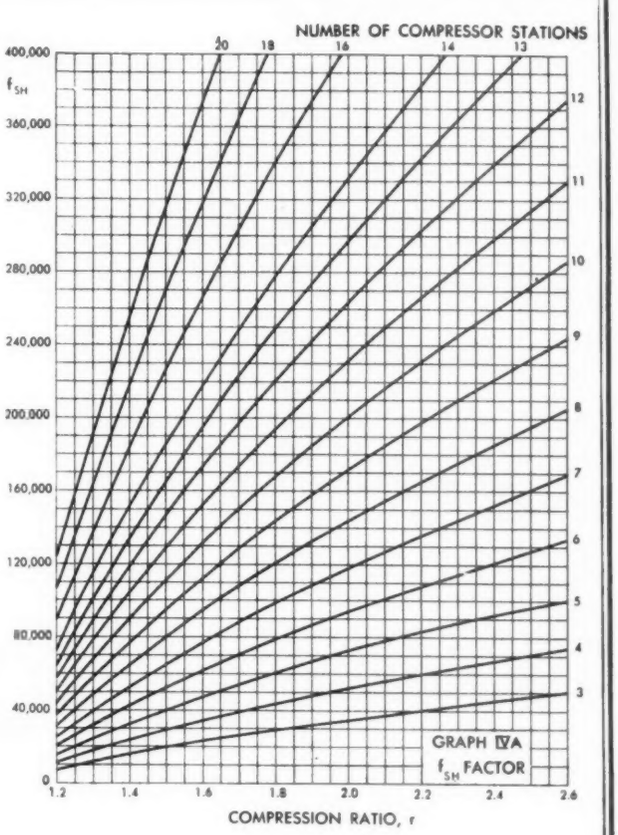
c_p. Specific heat at constant pressure.

C_v. Specific heat at constant volume.

C_G. Correction factor for specific gravity of gas, Appendix V.

C_E. Correction factor for mechanical efficiency of compressors.

C_S. Correction factor for working stress of pipe.



Graph IVA (above) plots values of f_{SH} vs. ratio of compression and the number of compressor stations over a wider range than that covered by Graph IV (sheet 3, P 662.01 published in installment No. 110.)

Graph V (see sheet 6) plots the loci of constant f_S at certain values against f_H for various compression ratios and numbers of stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent. By inspection it is apparent that the optimum ratio of compression exceeds 1.4 for all values of f_H up to 400. As 400 b.hp. per million cu. ft. of daily deliverability is a very high compressor saturation for even a long pipe line, 1.4 is, for all practical purposes, a lower limit for optimum ratios of compression.

Graph VI (see sheet 7) plots the loci of constant f_{SH} at certain values against f_H for various compression ratios and numbers of stations, for pipe stressed to 35,715 lb. per sq. in. and compressors having a mechanical efficiency of 90 per cent.

NOTE: All graphs in this series of tables are for gas of 0.607 specific gracity, angle type compressors of 90 per cent mechanical efficiency, and an allowable working stress of 35,715 lb. per sq. in., which allows a 1.4 design factor of safety for Grade B material. If conditions involving other specific gravities, working stresses, or horizontal compressors of higher efficiency are encountered, suitable correction factors must be applied to the f_S, f_H, and f_{SH} factors as shown in Appendix V.

Appendices II to V, inclusive, are published on sheets 8, 9, and 10, P 622.01.

This Ring Joint Seal featured exclusively in BROWN FINTUBE Sectional Heat Exchangers

Recognized by engineers everywhere as the ideal closure, this ring joint seal assembly avoids packed joints, glands, ground joint seals, screw unions, and all the operating and maintenance troubles resulting from ground joint and screw union construction.

Seating surfaces of the shell flange and fintube fitting are in full view, and easily accessible. They can be wiped clean of all grit and dirt before closing the seal,—not possible with inside ground joint construction. The soft metal ring overcomes any slight unevenness of the seating surfaces, and permits tight, leak-proof closures to be made time after time.

Enthusiastically endorsed by operating and maintenance departments of oil refineries and chemical processing plants, the ring joint seal is only one of the many exclusive features Brown Fintube Sectional Heat Exchangers can give you. Brown's exclusive "one-piece" fintubes whose high heat transfer efficiency is maintained undiminished during the entire life of the tube, —our exclusive non-removable rear end construction, and replaceable stud bolting throughout, are some of the others.

Send today for the fully descriptive catalog, and let our engineers help you in adapting Brown Fintube Sectional Heat Exchangers to your exact and individual requirements.

THE BROWN FINTUBE COMPANY

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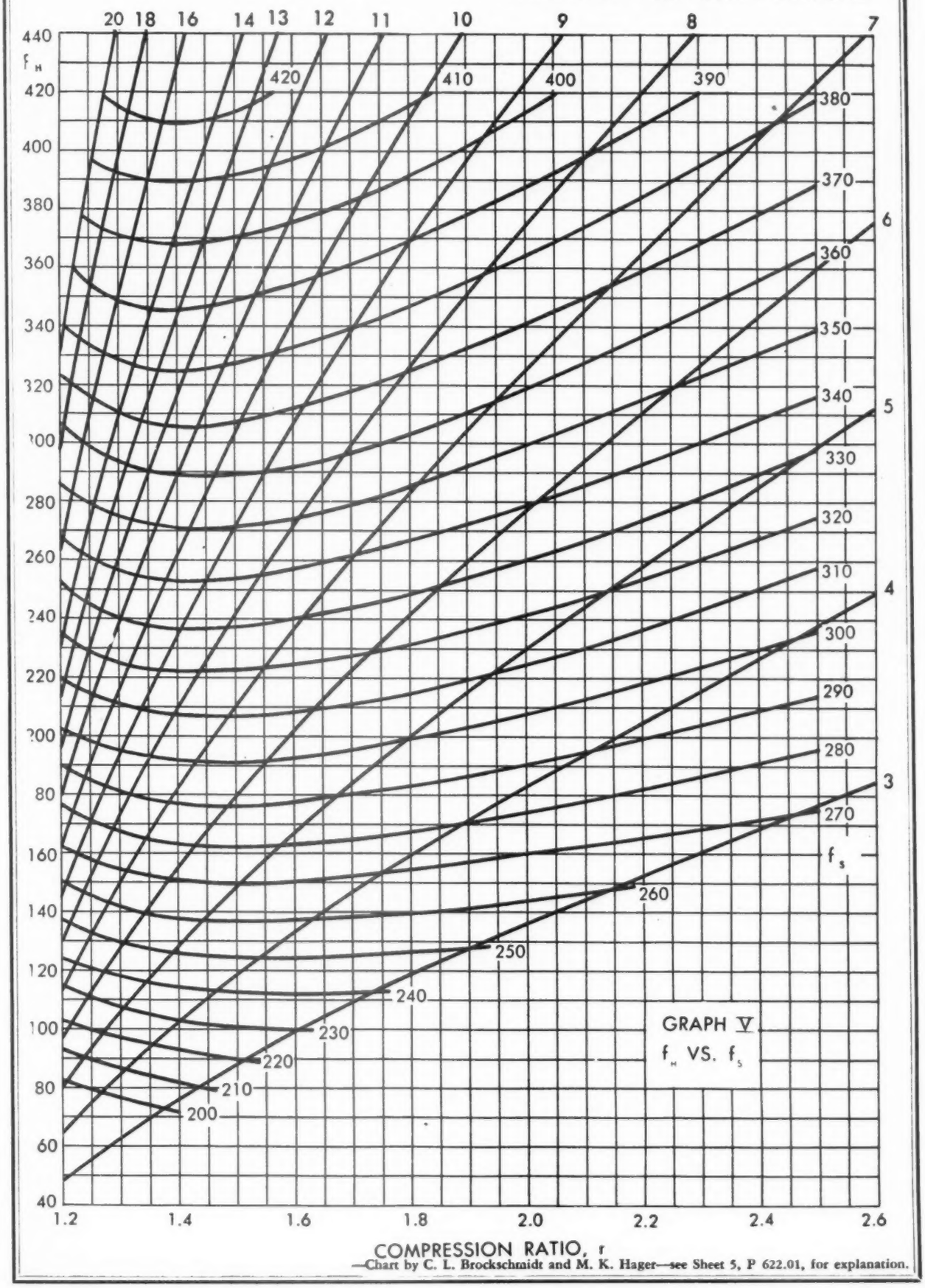
Send for Bulletin No. 452

MANUFACTURERS OF BROWN RESISTANCE WELDED INTEGRALLY BONDED ONE-PIECE FINTUBES, AND FINTUBE HEAT TRANSFER PRODUCTS

GAS PIPE LINE DESIGN FACTORS



—Chart by C. L. Brockschmidt and M. K. Hager—see Sheet 5, P 622.01, for explanation.

VALVES designed for the modern Refinery

Years ago, when American Industry was still in its infancy, The Wm. Powell Company adopted a definite, farsighted policy . . . to concentrate on making valves only—valves of *every* design, for *every* service in *every* branch of industry.

That is why, today, Powell can supply valves to meet every known flow control requirement in your plant. And, if you have any flow control problems, Powell Engineers will gladly help you solve them.

When writing for catalogs, kindly specify whether you are chiefly interested in Bronze, Iron, Steel or Corrosion-Resistant Valves.

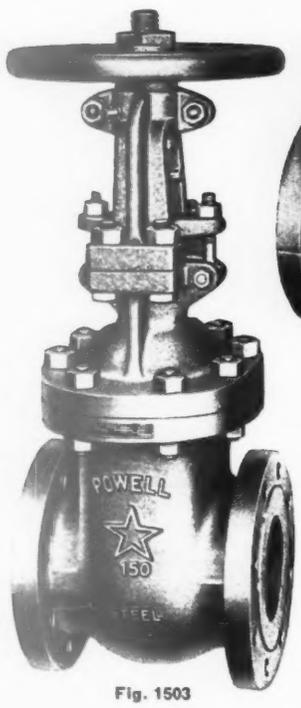


Fig. 1503

Fig. 1561

Fig. 1561—Class 150-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc, when wide open, permits full unobstructed flow through the valve body.

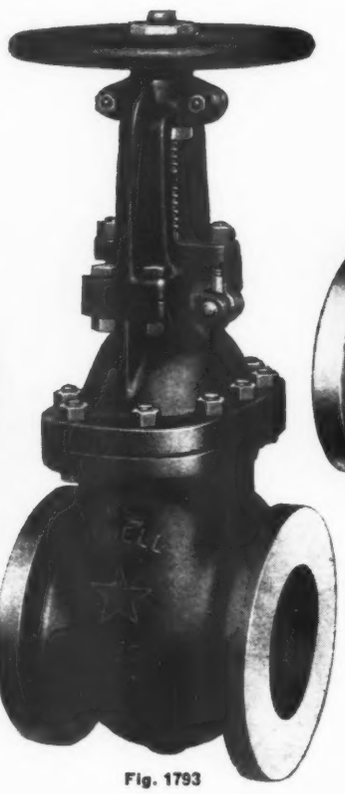


Fig. 1793

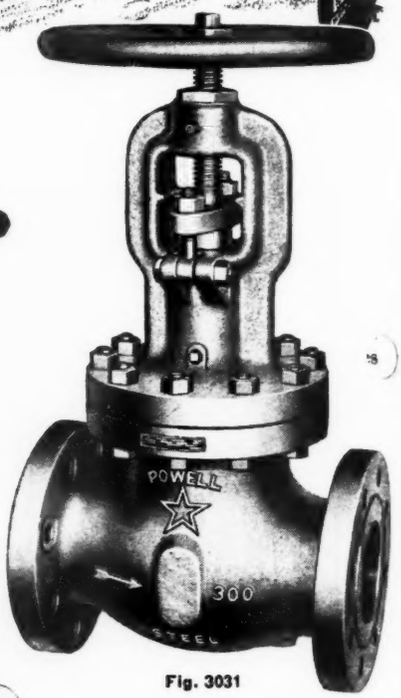


Fig. 3031

Fig. 1503—Class 150-pound Cast Steel Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc.

Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

Fig. 3031—Class 300-pound Cast Steel Globe Valve with flanged ends, outside screw rising stem and bolted flanged yoke.

The Wm. Powell Company, Cincinnati 22, Ohio

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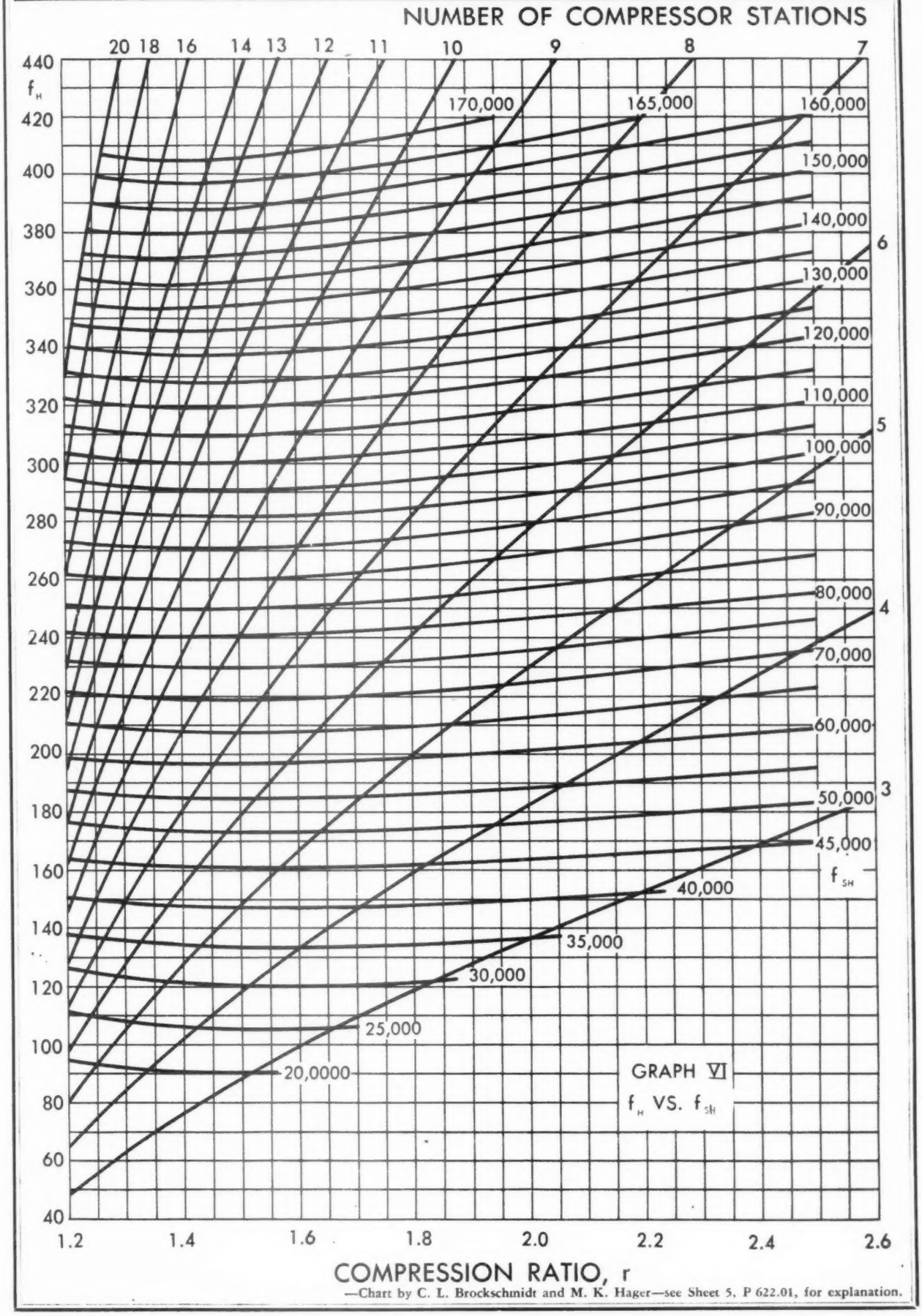
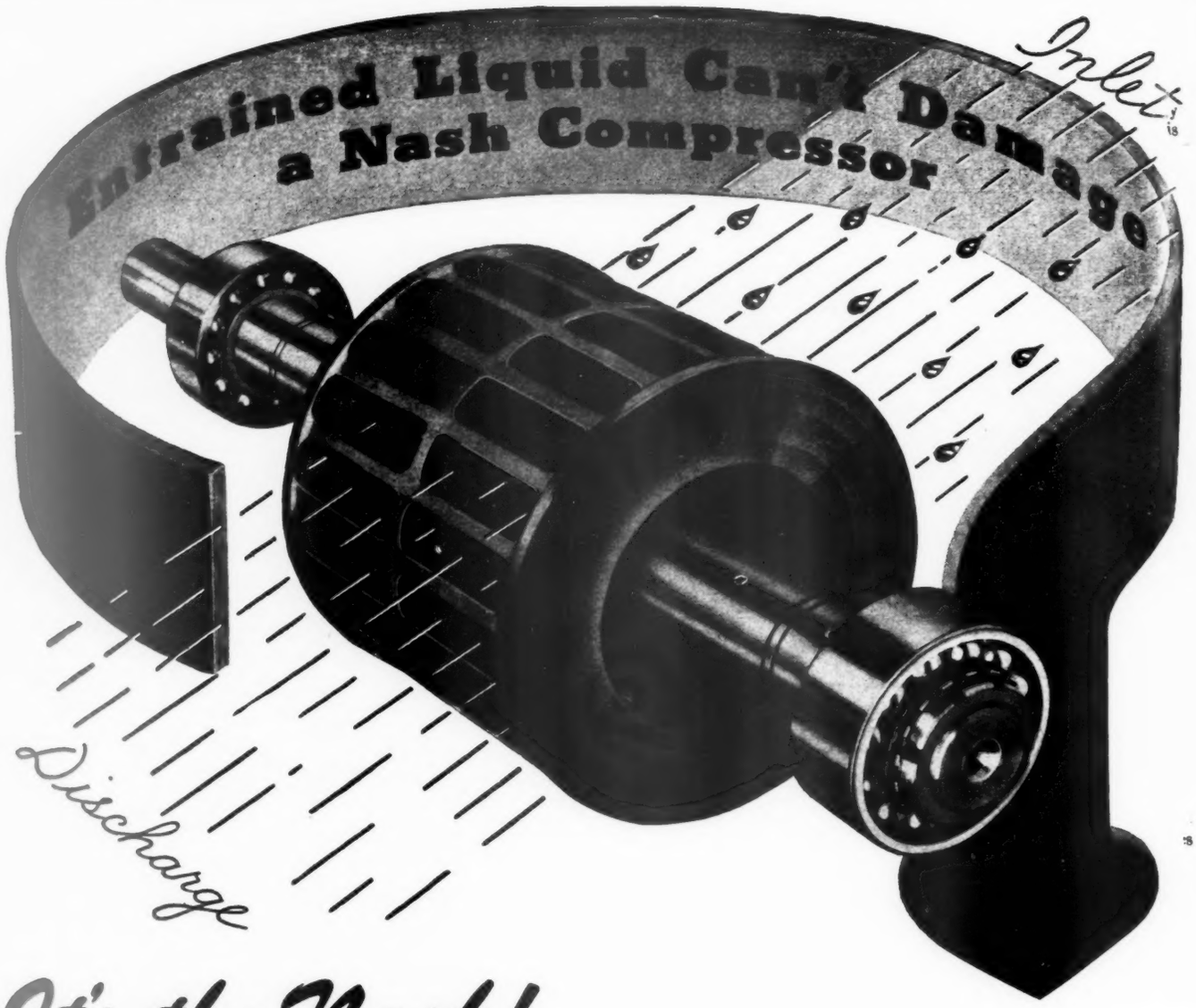
POWELL VALVES

GAS PIPE LINE DESIGN FACTORS



—Chart by C. L. Brockschmidt and M. K. Hager—see Sheet 5, P 622.01, for explanation.

Entrained Liquid Can't Damage a Nash Compressor



It's the Nash!

The ability of Nash Compressors to maintain original performance thruout a long life is only one of the many advantages which derive from the Nash liquid piston principle of compression.

Since this liquid piston is an integral part of the Nash Compressor, additional liquid can do no harm to the pump structure, whether in the form of slugs entering by accident, or as condensate forming in the suction lines. In handling gases, for example, wet hydrocarbons, usual elaborate protective devices are eliminated. The hazards of such devices are therefore avoided, the cost of installation is saved, and freedom from repairs and shutdowns is assured.

Nash Compressors produce 75 lbs. pressure, or vacuums to 26 in. of mercury, in a single stage. with capacities to 6 million cubic feet per day in a single structure. They have but one internal moving part, simple and non-wearing. There are no valves, gears, pistons, sliding vanes, or other enemies of long life. No gas contaminating internal lubricant is employed. Compression is without pulsation. It will be to your advantage to investigate the Nash Compressor.

26 in. mercury vacuum or 75 lbs. pressure in one stage.

No internal wearing parts.

No internal lubrication to contaminate gas handled.

Desired delivery temperature automatically maintained.

Non-pulsating pressure.

Original performance corstant over a long pump life.

Low maintenance cost.

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Oil accounting

By **JACK D. FARNAN,** General Petroleum Corporation

PART 1

● **Preface.** Accounting for the petroleum industry is definitely divided into two major classifications: (1) General accounting, and (2) oil accounting. General accounting concerns itself with capital expenditures, plant and equipment records, operating and maintenance expenditures, service systems, supervision, corporate overhead, and revenues from non-operating sources or from sources other than the sale of products. The general accountant is charged with the responsibility of keeping the general books of the enterprise and with the issuance of required financial statements.

EXCLUSIVE

Oil accounting is solely devoted to recording properly all movements and storages of oil and determining the costs thereof. Costing the oil movements of course necessitates the use of expenses that have been classified, recorded, and accumulated on the general books. The oil accountant and the general accountant, therefore, should work closely together and in harmony to the end that a suitable chart of accounts shall be evolved. This in order that needed summations readily may be available with the least amount of post analysis.

● **Scope.** The responsibility of the oil accountant is to provide for his employer a true and accurate record of all his oil from the moment of its acquisition—whether it is produced, purchased, or received on exchange—to the moment of its final disposition—whether that be through sales, usage, loss, or delivery on exchange. That means following each barrel of oil from the well through pipe lines, tank farms, refining processes, and out to the customer. The word oil as used herein should be understood to include wet gas and products of wet gas.

It is also the responsibility of the oil accountant to make certain that all legal obligations connected with the production or purchase of oil are discharged faithfully.

The oil accountant in his work is absolutely dependent upon measurements made in the field and recorded on run tags, gaugers' reports, pumpers' reports, stillman's reports, orifice meter charts, or some other media. The accuracy of his work likewise is closely related to the accuracy of laboratory tests as reflected in the results supplied him.

One of the greatest difficulties experienced by most oil accountants is that of getting operating men to realize the importance of keeping good records. It has in the past been nothing uncommon to have a gauger, for example, go out at say 6:00 o'clock some stormy morning, climb an 80,000-bbl. tank, carefully gauge the tank, and then write his findings down in so careless a manner that they are illegible. Some operating men never appear to realize that no matter how careful they are to make certain that there are no leaks, that the proper valves are open or closed as the case demands, that temperatures and pressures are maintained exactly right, this is not enough. The only means the employer has of getting money into the till in order to meet his payrolls and other obligations is to sell products or services to someone. If through a careless or inaccurate record the quantity of products sold or the extent of services rendered is understated the employer has suffered a loss just as surely as though a tank had been permitted to run over or its contents permitted to leak away.

● **Oil lands.** As stated, oil accounting begins at the moment of acquisition of the oil. It is fitting, therefore, that a discussion of oil accounting should begin in the field on the producing property.

It is quite well known that the same law of capture that applies to wild animals also applies to oil. Wild animals roaming over private property do not belong to the owner of the property unless and until they are captured. Oil underlying private property does not belong to the owner of the property unless and until it is produced. Of course, if you as lessee or operator of a property permit underlying oil to be drained away you are very apt to find yourself involved in a law suit or at least subject to compensatory royalties. Likewise, if a well drilled from a rig situated on your property is bottomed under someone else's property you are also in difficulty.

Oil lands are held and operated in a number of ways. The simplest is where the land is owned outright, that is, owned in fee and operated by the owner. Oil lands owned by one operator may be leased by the owner to another operator, in which case the owner retains a royalty

REPORT OF CRUDE OIL PRODUCTION, DELIVERIES AND STORAGE

COMMODITY ..... CRUDE
FOR [PERIOD / MONTH OF] ..... 19....
DELIVERED BY PRODUCTION DEPARTMENT
FROM ..... LEASE FEE
DELIVERED TO GATHERING SYSTEM
AT ..... DIVISION

DESCRIPTION OF TRANSACTION — DETAILS	GRAV A.P.I.°	NET BARRELS 42-U.S. GALS. EACH	*	UNIT* PRICE	*	AMOUNT* DOLLARS	CTS	*
* DELIVERIES TO GATHERING								
*								
*								
*								
*								
*								
*								
TOTAL DELIVERIES								
STORAGE—6 00 A M 19								
TOTAL CLOSING STORAGE 19								
TOTAL DELIVERIES AND STORAGE								
LESS STORAGE—6 00 A M 19								
*								
*								
GROSS PRODUCTION								
* TOTAL ROYALTIES								
* NET PRODUCTION								
*								
* GROSS PRODUCTION								
* LESS USAGE								
*								

COMPILED BY / APPROVED BY / COMPILED BY / APPROVED BY / COMPTOMETERED
FIELD OFFICE / FIELD OFFICE / OIL SECTION / OIL SECTION

NOTE—Columns, and/or lines in respective column headings marked with asterisk (*) only, must not be filled in by Field Accounting Office

DAILY REPORT OF WELL PRODUCTION

REPORT NO. _____
SHEET NO. _____

REPORT FOR 24 HOURS ENDING 6:00 A. M. 19 DIVISION LEASE

* WELL NO.	* TANKS AND SUMPS	* GAUGES * LONG FT.	IN.	SHORT FT.	IN.	* GROSS FLUID	* GRAV. °API	* TEMP. °F.	* WELL CUTS WATER %	EMUL. %	SAND %	TOTAL %	ESTIMATED NET BARRELS PHONED PROD. DEPT. DAY	MONTH TO DATE	ADJ. +OR-	ACTUAL PROD. MONTH BARRELS	HOURS OFF * DAY	MONTH TO DATE	REMARKS
TOTAL																			

IN COLUMNS INDICATED (*) INFORMATION TO BE FURNISHED BY OPERATING DEPT., IF REQUIRED

REPORT OF LEASE STORAGE AND SHIPMENTS DELIVERED MONTH TO DATE BBLS.

* TANK NO.	* OVERALL FT.	IN.	GROSS FLUID	* WATER FT.	IN.	BBLS.	GROSS OIL BARRELS	* GRAV °API	* TEMP °F.	* M&BS %	NET OIL STORAGE BARRELS	DELIVERED PAST 24 HOURS RUN TAG NO	NET BARRELS	STORAGE PLUS DELIVERIES	NET STORAGE PREV. PERIOD	NET PROD. BBLS.
RECEIVING TANKS AND SUMPS AT WELLS																
TOTAL																

TOUR NO. 1 _____ PUMPER TOUR NO. 2 _____ PUMPER TOUR NO. 3 _____ PUMPER APPROVED _____ FOREMAN

interest and looks to the operator for an accounting.

Land that is leased by the operator from the landowner is usually subject to a landowner's royalty and if leased through a third party may also be subject to an overriding royalty. Lands leased by an operator may in turn be sub-leased to another operator with the original lessee retaining an overriding royalty.

Several parcels of land subject to different royalty rates or having different royalty interests are often covered by a single lease. The royalties from certain wells on the same lease frequently are payable to different individuals. The complexity of the royalty provisions of many leases makes a careful study of them mandatory. Every effort should be made at the time a lease is entered into to avoid ambiguous language. It should always be kept in mind that failure to comply with all provisions of a lease, even though inadvertently, may result in the loss of a valuable lease.

The practice of drawing up community leases, as a means of consolidating a number of small holdings in town lot areas into one sizeable lease, has recently come into favor. Under a community lease the participating acreage of each parcel is divided by the total participating acreage of the lease and the percentage thus arrived at is termed the participating percentage, totaling, of course, 100 per cent for the lease. These participating percentages are then used to allocate oil produced from any portion of the community lease ratably to all parcels within the lease. Such leases also usually provide for the payment of surface rental to the owners' of the land whereon equipment is situated.

The unit plan for the development of oil fields has gained considerable popularity by reason of its economic appeal. A unit plan is similar to a community lease but on a much larger scale. The agreement creating a unit must provide a method for determining the participating area and for changing that area as the oil field develops. Each operator signing the unit agreement enters certain specified lands in the unit. The acreage of each operator's land lying within the participating area compared to the total acreage within the participating area determines his percentage of participation and serves as the basis for allocating production from the unit. The land entered in a unit by an operator may be owned in fee or held on lease. When the land is leasehold the lessors' consent to participation in the unit is required. Usually the operators signing a unit plan appoint one of their number as the unit operator. At Kettleman Hills, however, the Kettleman North Dome Association was formed by the participating companies for the purpose of operating the unit.

Another method of operating oil lands is by the formation of a copartnership. Two or more companies or individuals agree to operate a certain property for their mutual benefit. One of the partners is designated as the operating partner and revenues and expenses are shared according to an operating agreement.

The obligation of protecting the rights and interests of the lessor clearly rests with the original lessee. This fact must be kept in mind when executing subsequent agreements.

● **Production.** Crude oil from the well ordinarily is first run into individual well tanks, although at times, when production is heavy crude, certain wells may be produced into an open sump.

The individual well tanks are usually of 100-bbl. capacity and so constructed that they contain approximately 1 bbl. of liquid for every inch of depth. Well tanks, as a rule, are not strapped and measurements of oil in them are used only for such purposes as providing a daily estimate of well production.

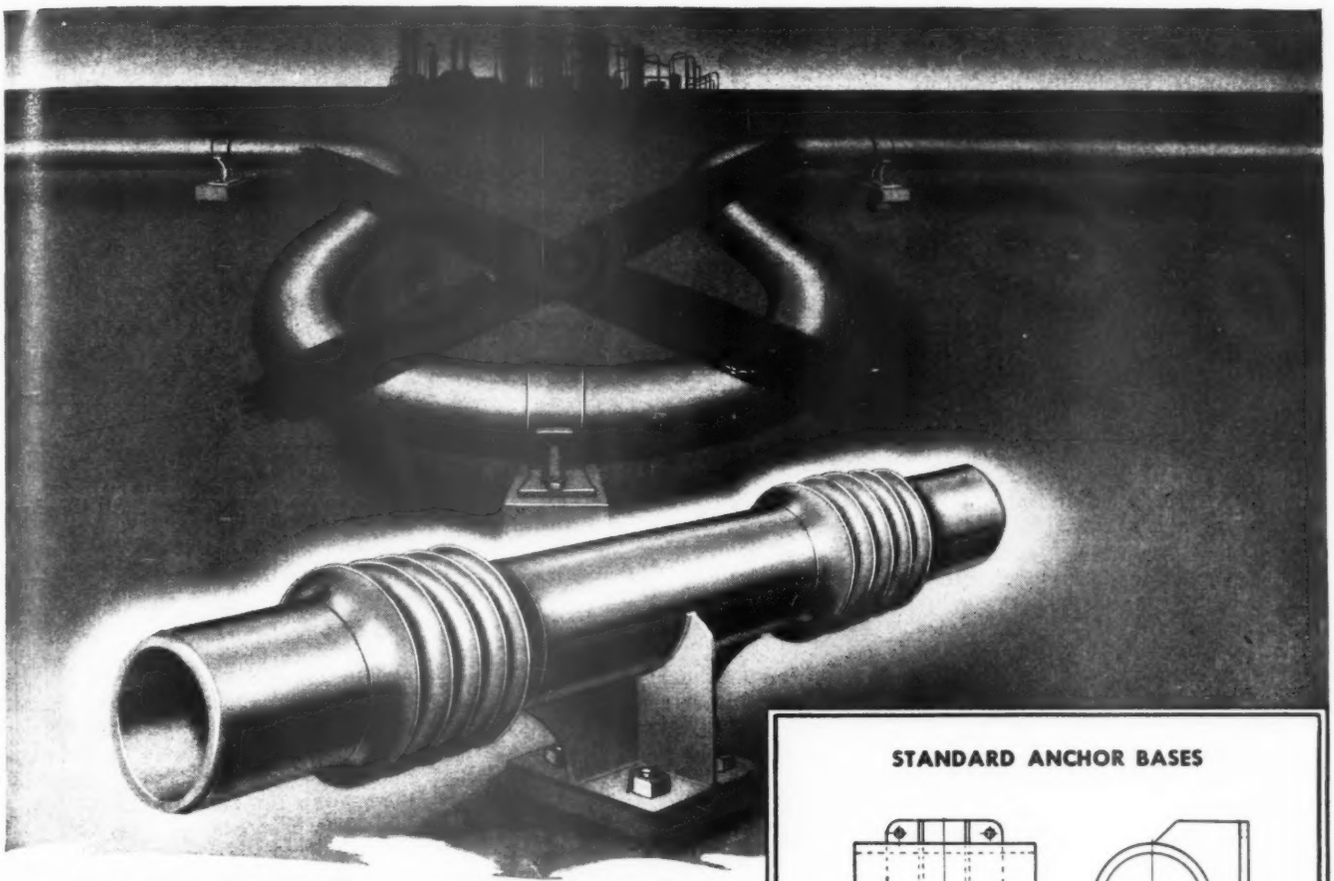
A great deal of difficulty is encountered in estimating production from wells producing directly into open sumps. Such estimates usually are little better than guesses and should be so regarded by the accountant.

Recently the practice of metering production from individual wells has gained popularity. Weighmeters or positive displacement flowmeters have been used to good advantage. The characteristics of the fluid produced and the use to be made of the readings obtained are considered by the production engineer in determining the type of meter to be used.

Daily estimates of production serve as the basis for prorating actual measured production for the month or other accounting period back to individual wells.

Crude oil is run from the well tanks to clean shipping tanks or, if wet, to dirty (wet) storage tanks. As a matter of practice separate shipping or storage tanks are provided for each lease or for certain wells or groups of wells where contractual obligations make segregation of the oil imperative.

The ordinary crude oil purchase contract provides that oil cutting in excess of 3 per cent M&BS will not be accepted and 3 per cent is the maximum acceptable to pipe-line companies. This necessitates the dehydration of oil cutting in excess of 3 per cent after draining off free water. Dehydration is accomplished by the addition of chemicals, by the application of heat, or by the use of a patented process. The use of a patented



ANCHOR JOINTS *Simplify* Piping

MAGNILASTIC ANCHOR JOINTS permit rigid anchoring of pipe lines while permitting thermal expansion and contraction. Piping can now be anchored at a number of accessible points, to maintain alignment. But . . . varying amounts of contraction and expansion, due to differences in pipe lengths and temperatures, take place on each side of the anchor point. MagniLastic Anchor Joints, by varying the number of bellows diaphragms at either end as required, absorb this unequal movement and yet permit the anchor point to remain stationary.

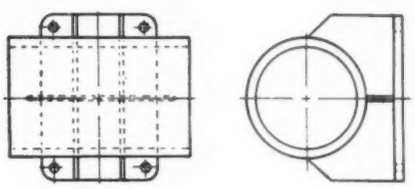
DAMAGING SURGE PRESSURES ABSORBED . . . In systems where severe hydraulic surges occur, MagniLastic Anchor Joints minimize the transmission of shock to the base and adjacent equipment.

IMPORTANT SAVINGS TO USERS . . . Anchor Joints produce worthwhile savings in installation costs, number of fittings and space required. Even more important are reductions in maintenance costs due to damaged piping and fittings.

CUSTOM FEATURES . . . MagniLastic Anchor Joints are available in all standard pipe sizes and for pressures to 1000 p.s.i. Welding ends are regularly supplied; pipe flanges and inner liners are optional. Special anchor mounts can be designed to user's specifications.

Write today for newly revised catalog containing full information on Anchor Joints as well as MagniLastic's complete line of Expansion Joints for all temperatures, pressures, pipe sizes and corrosive conditions. Address MagniLastic, 2700 Southport, Chicago 14. Request Catalog No. 204.

STANDARD ANCHOR BASES



MagniLastic Anchor Bases of standard design as shown are supplied with Anchor Joints in pipe sizes from ½" to 24". Complete dimensions are given in the new catalog described below.

SPECIAL ANCHOR JOINT UNITS

MagniLastic Expansion Joints and Anchor Bases can be furnished with a variety of fittings such as elbows, tees, ells, Y's, etc., for special applications. Two typical units are illustrated. In this way a single installation can satisfy several of these requirements at once: 1) rigid mounting, 2) accessibility, 3) minimum space, 4) allowance for thermal expansion and contraction, 5) thrust, and 6) misalignment. See your local distributor, or let the nearest MagniLastic field engineer suggest a solution to your problem.

MAGNI LASTIC

DIVISION OF
COOK ELECTRIC COMPANY
Chicago

Sales and Engineering Offices in Principal Cities

process requires the payment of usage royalties. The oil accountant in such cases must be supplied with monthly figures reflecting the dirty oil to the dehydrator and clean oil recovered, together with M&BS cuts.

Lease agreements frequently provide that oil cleaning costs may be charged back to the lessors. This charge-back may be at fixed rate per barrel of clean oil or a proportion of the actual cleaning costs. Such charges ordinarily are collected by contra-accounting royalties payable.

The first actual measurement of crude oil takes place in the shipping tank. Methods for measuring, sampling, and testing crude oil, as described in API Code No. 25 and revised from time to time, have been generally adopted as standard throughout the oil industry.

At the time a shipment of crude oil is to be made the opening (long) gauge is observed by gaugers for both the deliverer and receiver of the oil. Samples of the oil are taken and tested in the prescribed method to obtain the API gravity, percentage of M&BS, and temperature in degrees Fahrenheit. When shipment is completed the closing (short) gauge is observed and samples again taken and tested. This information is recorded on a run tag, which becomes the basic accounting record and should be preserved permanently.

REPORT OF GAUGER AT _____

FOR PERIOD ENDING 6 A. M. _____ **19**__

TANK NO.	GRAVITY	GROSS GAUGE FEET	GROSS GAUGE INCHES	WATER GAUGE FEET	WATER GAUGE INCHES	TEMP.	M. & B. S. %

COMPILED BY _____ GAUGER

CERTIFIED CORRECT _____

The run tag should provide space for all needed information, such as the date, location, property from which oil is received, facility to which delivery is made, number of the tank in which the oil is gauged, API gravity, long and short gauges, temperatures, M&BS cuts, and space for extending the tag to net barrels of oil. Run tags should be numbered serially for ready reference. It is good practice to establish a separate series of consecutive monthly run numbers for each property in addition to the serial numbers. Under this method a break in the monthly run numbers is immediately indicative of a lost run tag. Each run tag should be signed by a witness for the deliverer and a witness for the receiver of the oil. Sufficient copies must be provided to make the required distribution. The original run tag should be retained by the deliverer of the oil.

(MONTHLY RUN NO.____) RUN TAG 35053

Station or Dept._____ _____Date

Del'd to_____ OIL ACCOUNTANT
NAME OF COMPANY

Rec'd from_____
COMPANY OR DEPARTMENT

at_____

the following_____in Bulk of 42 Gals. per Bbl.

Run from_____to_____
TANK NO. OR DEPT. TANK NO. OR DEPT.

GAUGED IN TANK NO. OBSERVED GRAVITY ° API AT ° FAHR.

CORRECTED GRAVITY ° API AT 60° FAHR.

	GAUGE FT	GAUGE IN	GROSS BARRELS	TEMP	BARRELS AT 60°	% M. & B. S.	NET BARRELS
Long Gauge							
Short Gauge							
Oil Run							
Correction (Plus or Minus) for Temp. Coef.							
Net Amount Received							

First Measurement — Receiver's Witness

Date_____ Deliverer's Witness

Time_____M

Second Measurement — Receiver's Witness

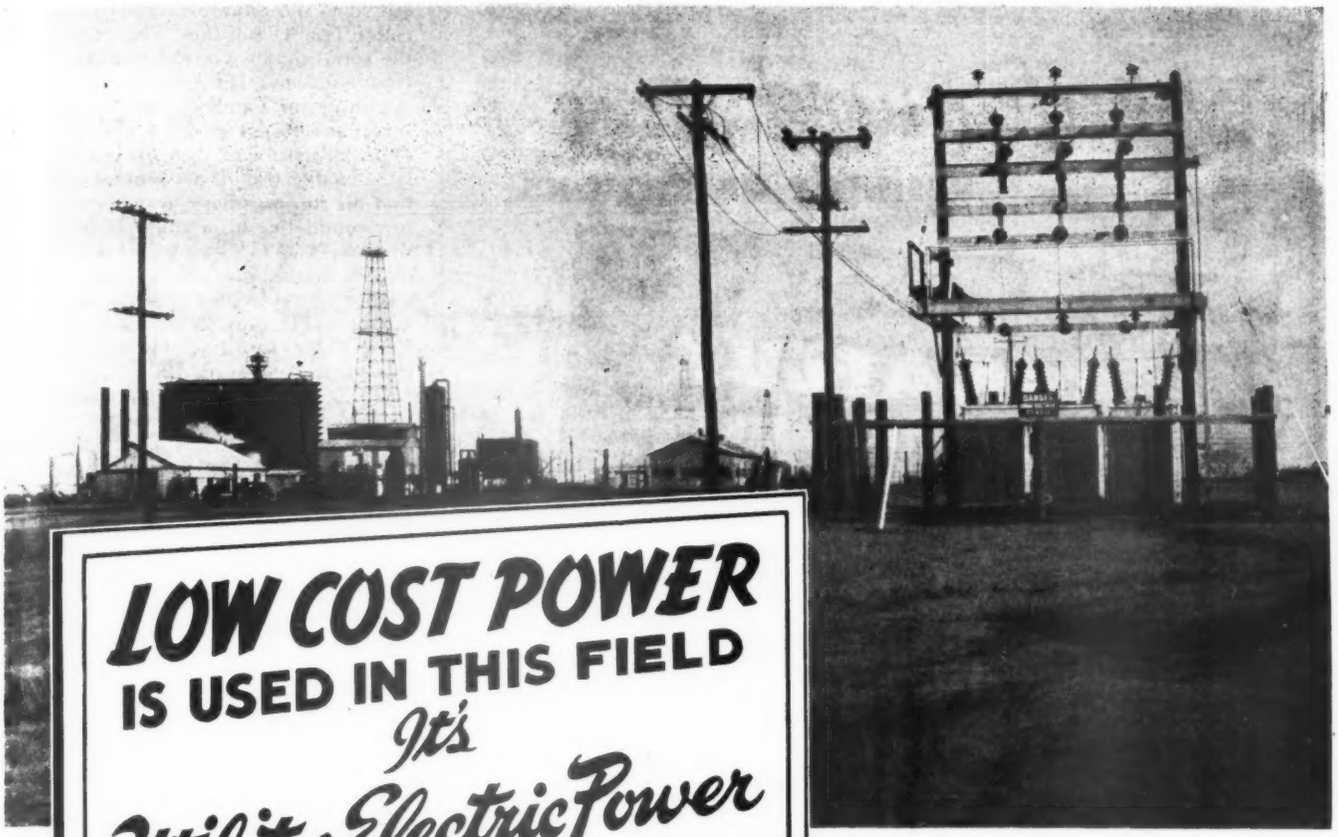
Date_____ Deliverer's Witness

Time_____M

Original to be Sent to Party or Department Delivering Oil

The oil accountant, upon receipt of his copy of the run tag, extends the tank gauges shown in feet and inches to gross barrels of fluid by reference to prepared tank tables. Gross barrels are corrected to barrels at 60°F. by multiplying by the correction factor obtained from the Abridged Volume Correction Table for Petroleum Oils (Supplement to NBS Circular C410) published by the National Bureau of Standards. Barrels of fluid at 60°F. are corrected to net barrels of oil at 60°F. by deducting the barrels of M&BS determined from the indicated percentage. The observed API gravity is corrected to API gravity at 60°F. by reference to Table 1, National Bureau of Standards Circular C410, and the corrected gravity is used to determine the applicable posted price for valuing the oil. The quantity of crude oil at 60°F. and the value thereof is then credited to the property of origin and debited to the receiver of the oil.

A register of run tags received should be maintained by the oil accountant in numerical order. This is best accomplished by the use of registration cards placed in each book of run tags. At the time a new book is placed in service the location, date, beginning and ending serial numbers are inserted on the card by the responsible party and the card sent to the oil accountant. Upon receipt of each run tag the date is stamped on the correct line of the appropriate card. At the close of each accounting period a "Report of Last Run Tag Issued" is sub-



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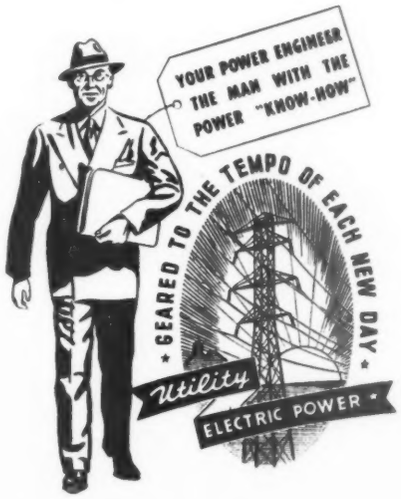
When wells go on pump, the important question is "What is the most economical and dependable method of lifting this oil?" If your investigation is careful and thorough you'll select Utility Electric Power, because in actual dollars and cents, it *costs less* to lift a barrel of oil—when ALL costs are considered!

With Utility Electric Power there is less capital investment to be amortized over the years. Expensive overhauling of power equipment and other costly items of maintenance are practically eliminated. There is just one monthly bill to pay, which for tax purposes is an operating expense.

For an actual dollars and cents breakdown of what it will cost you to lift a barrel of oil, call the Power Engineer of your local Utility Electric Power Company. He will be glad to furnish you with the figures . . . at no cost.



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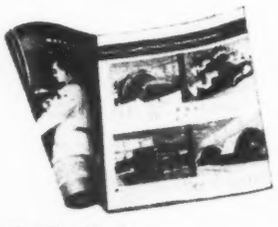

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When you write for information, ask specifically for this valuable bulletin . . . it features new and interesting facts about Magnaflux Field Inspection Service that offers dependable, low-cost protection against equipment failure. Quick service is assured by strategic location of Magnaflux Field Engineers at key points throughout the country.

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mitted to the oil accountant by each location issuing run tags. This report lists the serial number of the last tag issued from each unfinished run tag book, the monthly run number, and a brief description of the transaction. The purpose of this report and the run tag register is to enable the oil accountant to know that all run tags have been received before completing his accounting for a particular period. This system makes it necessary that in the event a run tag is spoiled or voided for any reason the oil accountant's copy be plainly marked "VOID" and sent in to him in the usual manner for registration.

Oil in storage in lease shipping tanks is gauged at the close of each month and the gauger's report showing tank numbers, API gravities, gauges, temperatures, and M&BS cuts, is supplied the oil accountant who extends the gauges to net barrels of clean oil.

A "Report of Crude Oil, Production, Deliveries and Storage" is prepared by the oil accountant for each producing property for each month. This report reflects the following information: Name of the property, period covered, total of deliveries by destination showing gravities, oil in storage at the close of the period by gravities, gross production, total royalties, and net production. This report shows both barrels and value. The quantity and value of gross production is arrived at by adding to the barrels and value of closing storage the barrels and value of total deliveries and from the total thereof deducting the barrels and value of opening storage.

Royalties are computed on the barrels and value of gross production, less the barrels and value of oil used on the property, or on barrels and value of oil delivered off the property, whichever is provided in the lease. When royalties are paid on a delivery basis good accounting practice requires that they be accrued on a production basis.

When the lessee or lessor requires that royalty be delivered in kind (as oil) the lessor is given credit on an exchange for the quantity and value of oil due him each month. Actual deliveries to the lessor are charged against the exchange. The difference between quantities due and quantities delivered remain at the close of the month as a balance due the lessor or a balance due the lessee, as the case may be.

When the royalty is to be paid in cash the amount of such royalty is computed by the oil accountant in accordance with lease provisions and a request for voucher check prepared. Such request in addition to the name of the payee and the amount should show the basic information upon which the royalty is based—this for transcription to the voucher portion of the check. Royalties due the United States Government or due various states must be accompanied by the completed forms printed and supplied to the operator by the various governmental bodies. The amount paid out as royalties is recorded on the books as the cost of royalty oil purchased.

★ ★ ★

P 615.5

New East Houston delivery station

By **L. F. SCHERER,** Chief Engineer, The Texas Pipe Line Company

and **C. L. McNEESE,** Industrial Engineer, Houston Lighting and Power Company

EXCLUSIVE

RECENTLY increasing demand for transportation of crude oil from New Mexico and West Texas to the Gulf Coast area and the difficulties encountered in procuring additional pumping equipment, pipe, and other critical materials, forced the Texas-New Mexico Pipe Line Company to obtain increased main line throughput capacity of approximately 10 per cent by utilization of a minimum of new equipment and critical materials. Capacities of some of the existing pumps were increased by installation of larger diameter plungers, and the required additional horsepower of diesel engines to drive them was accomplished by adding superchargers. Sectionalization of the main trunk pipe line was modified and balanced by the construction of a few short loops. The final step in this expansion program was the recent construction of a pump station at East Houston to facilitate deliveries of crude oil to the several terminal points in the Houston area.

This new pump station went into operation on July 19, and is illustrated by the photographs and drawings accompanying this article. The station has a delivery capacity of more than 90,000 bbl. of crude oil per day. Two high-speed motor-driven centrifugal pumps are manifolded to operate either independently or in series. These pumps are high volume at relatively low head, each developing approximately 175 lb. per sq. in. Each pump is driven by a 350-hp., 2300-volt, 3600-r.p.m. squirrel cage motor.

Control equipment consists of an incoming line panel with breaker, and reduced voltage starter for each unit. Push-button start and stop controls for the two units, as well as for five auxiliary suction units situated in the tank farm, are centralized on a bench type control board placed at a window between the control room and the pump and motor rooms, as shown in Fig. 1. The station operator can at all times obtain an unobstructed view of all the equipment in both rooms. Duplicate push button controls are provided on the motor starting panels in the control room. Instrumentation consists of an indicating voltmeter and a watthour meter on the incoming line panel, together with an ammeter on each motor control panel.

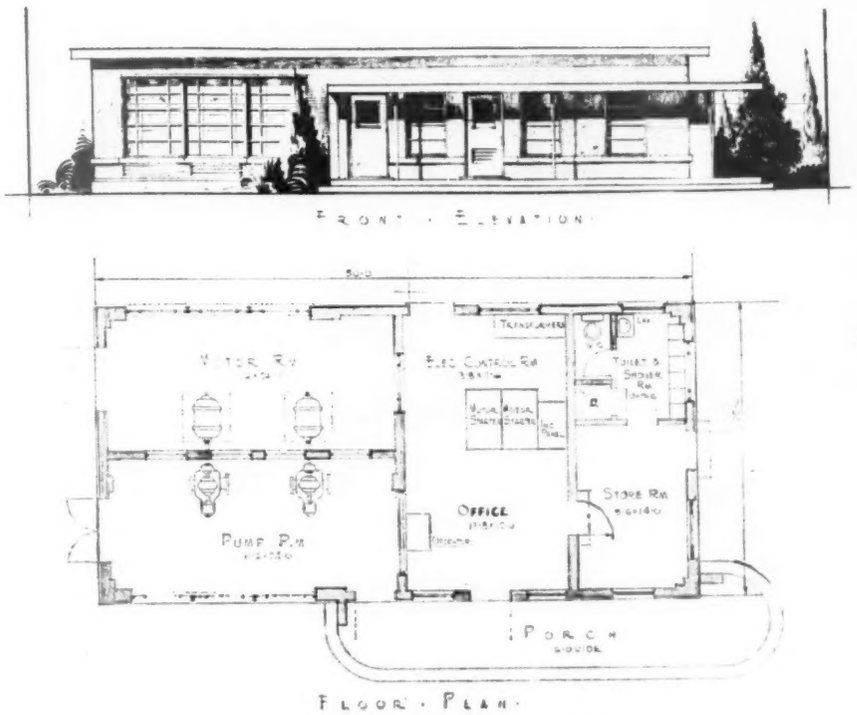
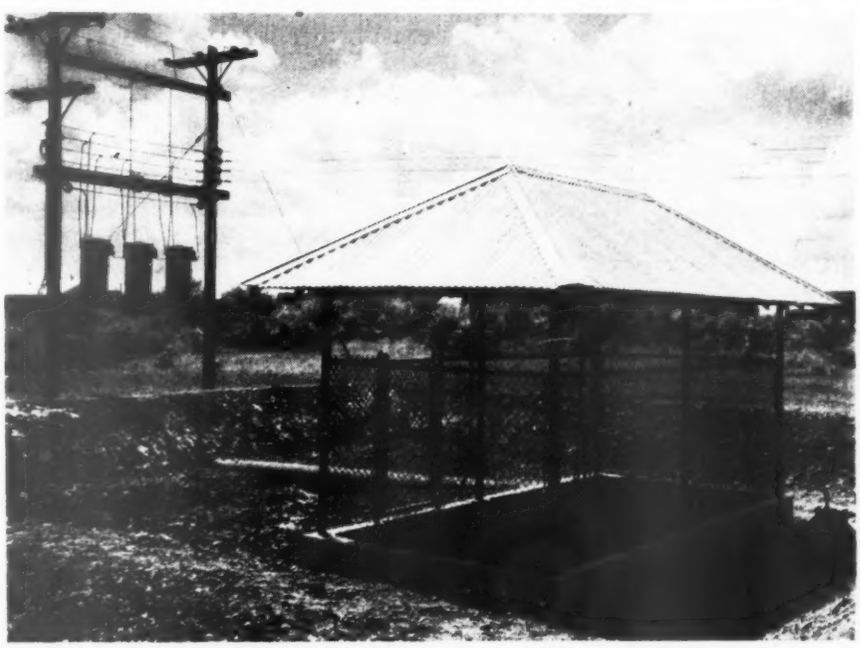


FIG. 1. Architect's drawing of front elevation and floor plan of new station.

FIG. 2. General view of one of the five auxiliary suction units in the tank farm.



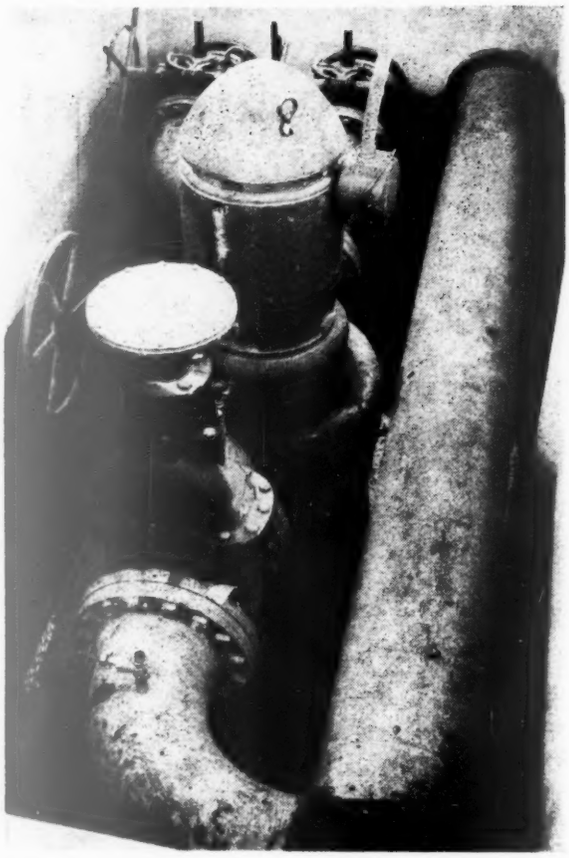


FIG. 3. Detailed view of auxiliary suction unit, showing piping arrangement and 25 hp. vertical motor driving centrifugal pump.

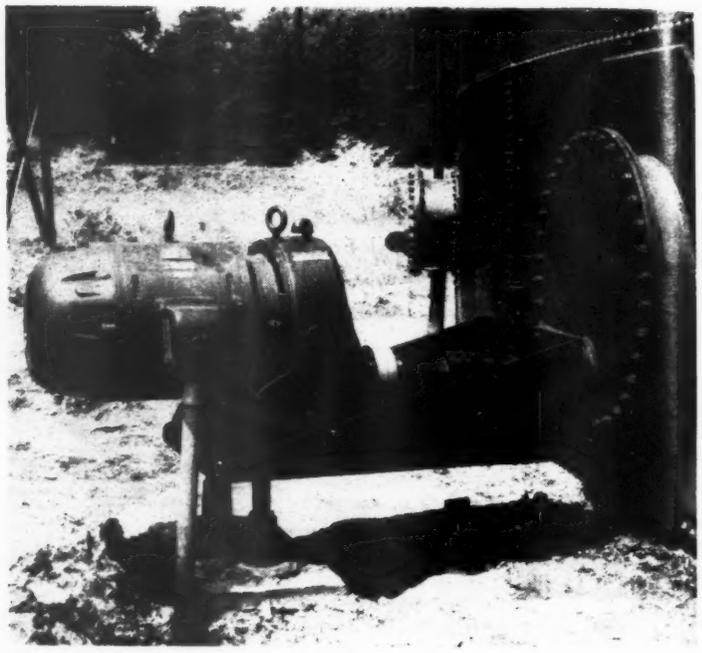
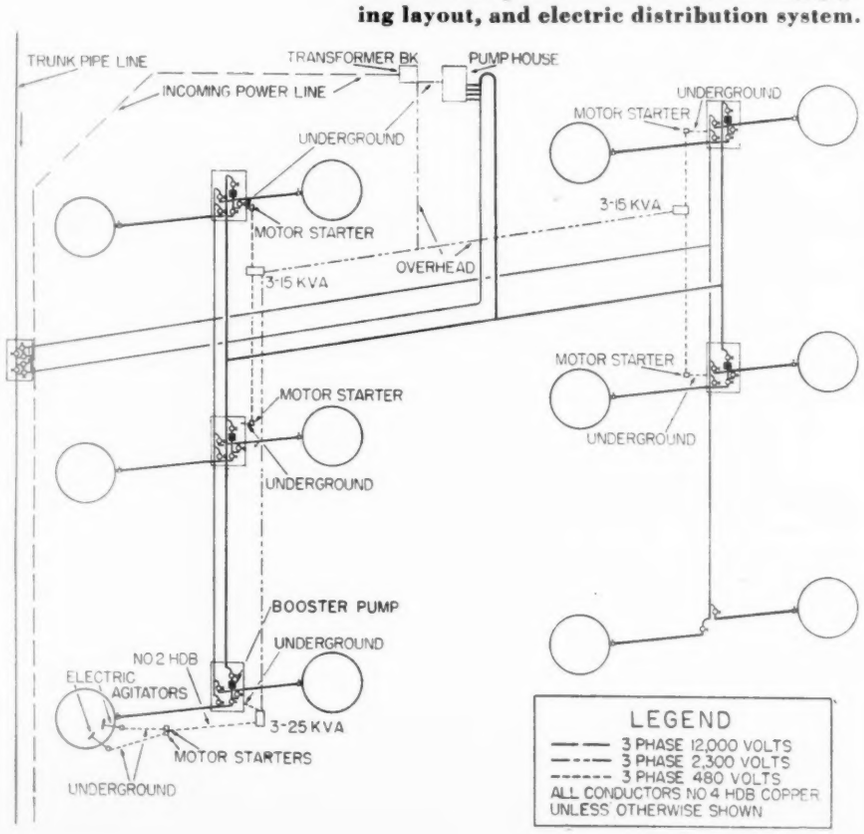


FIG. 4. Propeller type agitator for elimination of water bottoms.

FIG. 5. Plot plan of tank farm, showing piping layout, and electric distribution system.

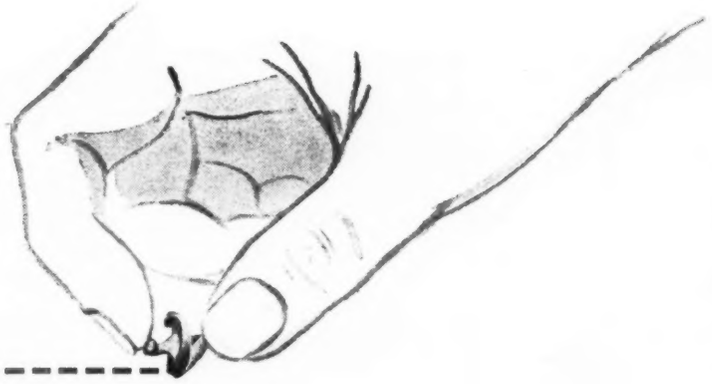


Each of the five auxiliary suction units in the farm of ten 55,000 bbl. tanks is manifolded so that it may draw out of any pair of tanks. Each unit consists of a centrifugal pump driven by a 25-hp. motor, with adjacent push button control, as well as remote control by push buttons mounted on the central board in the pump station. Views of one of the suction units are shown in Figs. 2 and 3.

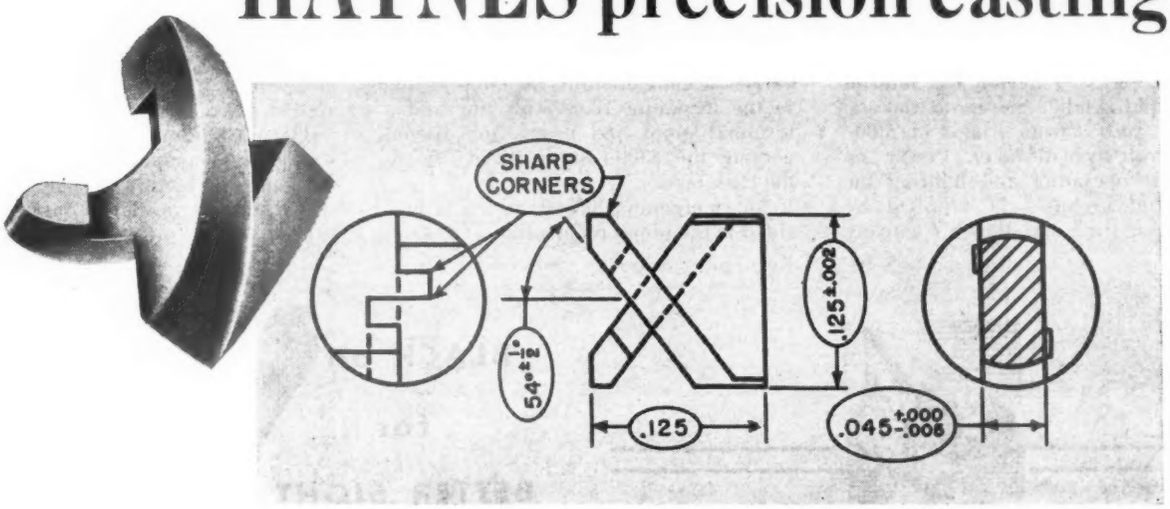
Each tank is provided with an individual filling line laid to a grade that will permit drainage to a common point. Tank capacity has been increased by arranging suction lines so that each tank can be drawn down to within 2 ft. of the bottom. One tank is provided with propeller type agitators, one of which is shown in Fig. 4, for the purpose of determining the feasibility of eliminating water bottoms.

The pump station building is of brick and tile construction with flat insulated roof, as illustrated in the architect's sketch, Fig. 1. The interior arrangement stresses safety and simplicity. Firewalls separate the pump from the motor room and the control room from both. For safety and comfort in the control room and office, a pressure equivalent to 2 in. of water is controlled and maintained by adjustable door louvers. Lighting for the pump room and motor room is provided through explosion-proof incandescent fixtures, and in the office and control room and other spaces by fluorescent fixtures. Heating for the office-control room, toilet, and storage space is provided by strip heaters placed in the ventilating fan ducts.

This small and intricate part---------



is economically produced by HAYNES precision casting



This spray nozzle core is made of HASTELLOY alloy C because it must resist corrosive chemicals. In spite of its intricate design and small size, it is produced to close tolerances by HAYNES Precision Casting—and is produced in quantities.

Parts of many sizes and shapes with internal and external threads or cored holes can be precision-cast with little or no finishing required. From the HAYNES line of high quality alloys you can select the one with the best combination of properties you require to resist abrasion, heat, or corrosion.

If you are interested in the properties of HAYNES corrosion-resistant alloys, write for the booklet, "HASTELLOY High-Strength, Nickel-Base, Corrosion-Resistant Alloys," Form 3361. If you want to know more about the precision casting process, ask for "HAYNES Precision Castings," Form 6244.

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FIG. 6. View of new station (back), with 1000 kva. 12000/2300 volt substation at left.

The motors driving the auxiliary suction pumps are supplied by 3-phase, 2300-volt circuit and will operate at 480 volts from three transformer banks shown in Fig. 5. Exterior and interior lighting and smaller motors at the station are supplied from a bank of 2300/120-240 volt transformers. Power required for operating and lighting the station and premises is supplied by Houston Lighting and Power Company and delivered at 12,000 volts through a 3-phase, 1000-kva., 12,000/2300-volt transformer as shown in Fig. 6. A simple wooden-pole substation structure carries a gang-operated pole-top switch in the incoming 12,000-volt line and a terminal point and means for disconnecting the 2300-volt overhead line to the tank farm.

An emergency shut-off station is provided in the pump room adjacent to each pump. All valves except those attached to the pumps are situated outside the station building. Miscellaneous facilities include a water well, a motor-driven sump pump, and a sewage disposal system.

The outstanding characteristics of this station is its compact simplicity, including improved features of electrically operated stations developed during the war period. ★ ★ ★

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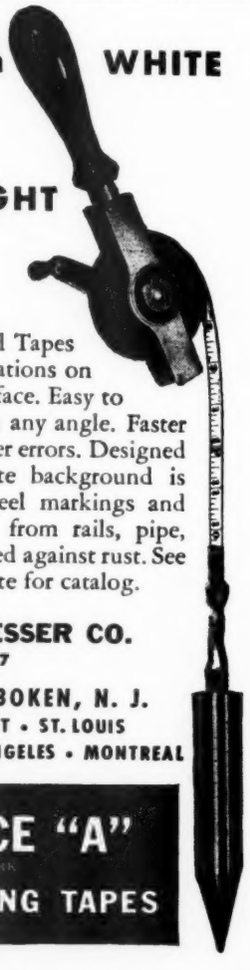

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Safety is a way of thinking

By **GEORGE F. PRUSSING,** *Technical Secretary,* Western Oil and Gas Association

EXCLUSIVE

We Americans believe in the sanctity of life to a degree never before exhibited in the history of the world. We have a compassion for suffering that makes us respond to calls for help no matter from what source. We give millions to every agency that appeals to us in the name of human suffering, and even individual cases, if sufficiently dramatized, open the flood gates of our generosity.

What is there about us that makes us so sympathetic to suffering? Is it that we are rich—or soft? To some extent we are both, and to some extent the fact must influence our emotions and our thinking. But certainly these are not the only stimulants, nor are they the basic ones. The truth probably lies in the fact that we are philosophically a Christian people, regardless of whether we as individuals are churchmen or nonchurchmen. The philosophy of compassion is part of our inheritance. Throughout the Declaration of Independence, the Constitution, and the laws of our land, runs the acceptance of the humanitarian principle that the life of every man is equally precious, and that suffering is a matter of community concern.

Without that background of a national philosophy of compassion, no movement for industrial safety could have excited such a universal interest, or accomplished such a universal good. Without that influence, the safety movement would have been merely another phase of the efficiency program, based on the theory that every accident involves waste of time, which in industry is waste of money. In fact, there are those in industry even now who measure accidents in dollar cost, and grudgingly attach a safety engineer to their claims department or agent. They are in the minority, happily, because although they do make a contribution toward accident prevention, it is not the maximum of which they are capable. They fail to realize and, hence, benefit by the fact, that for most Americans, compassion for others is a part of a national philosophy, so much so, indeed, that safety has actually become a part of our way of life.

It is not intended here to belittle the scientific or dollar approach to accident prevention. Eventually, in business, everything must be resolved into dollars for the purpose of striking a profit and loss balance. Injuries, and even death itself, can and do find their way on to the balance sheet. So strangely uniform are the patterns of human behavior that for any given industrial group, statisticians can fairly well predict how many broken arms and legs, how many burns and eye injuries, will have to be healed—and paid for in loss of productive time—in each succeeding year. Let us, then, give this approach to the problem its due. Let us say, as we honestly may, that quite apart from the suffering of the individual and his family and their loss of earnings or support, there is a real financial loss to the employer, which is normally reduced by several dollars for every prevention dollar intelligently spent. There we have justification for the large sums that must be appropriated in every organization of any dimensions, for preventing contingencies, that if not prevented, will cost a great deal more. The financial approach is based on the simple maxim that it is better to pay a little now than a lot later. In a large concern with adequate capital, it is obviously good business to appropriate whatever can be effectively spent in advance, rather than pay the larger price that results are certain to demand later, if no prevention money, or too little, be spent.

Thorough training of novice employes by capable teachers insures greater safety and fewer accidents.

The small operator, working on a shoestring, even a long shoestring, cannot always take that attitude, for the simple reason that his capital is limited. Those who visited small plants of every description during the war period know how difficult it was to jar loose the few dollars necessary for even rudimentary guarding of hazardous equipment. Some small firms either did not have the necessary money, or simply felt that they were going to be in business such a short time they would rather take chances than venture capital on accident prevention. The same thing was evident in the little tea kettle outfits that still make up the greatest number of refineries in California. Even when the equipment was new to begin with, they cheated on the spacing and fire protection that limits losses when the inevitable flash occurs. Those familiar with drilling and producing know what haywire design and operation are among small operators. In such outfits, the dollar approach fails completely when dealing with the safety problem.

What has been said of the small employer applies in even greater measure to the employe, whose only possible dollar concern in accident prevention, is the remote mathematical chance that he will be the one out of all the thousand to be deprived of his livelihood. That is too small an incentive for a self-confident and self-sufficient man. He scorns the thought that he should want to protect himself from harm, as a symptom of personal cowardice; but talk to that same man about the man next to him, or the men who work for him, and note the difference in attitude. There is no cowardice in compassion for the other fellow, or for his wife and children. It is a waste of time to say, "Be careful or you'll break your fool neck!" The answer is likely to be, "Well, it's my neck, isn't it?" But if you say, "Let's do this job or guard this equipment, so that some poor guy doesn't get hurt when he is thinking about family troubles instead of his job," you get a response that comes right from the heart. Even foremen who are often reputed to be tough, and who certainly have no easy jobs these days, will take greater interest in prevention when it is propounded as a help to their fellows, rather than through any other approach.

Petroleum workers are, of course, unusually fortunate, because petroleum management is thoroughly convinced of the moral and financial value of preventing accidents and fires. The problem of selling safety to owners and managers is not a matter for today's consideration—they have long been sold. Nor is there any evidence that petroleum management will ever take the attitude that it may now relax its interest and support because everything that could be done has been done. The need for safety training and the development of safety consciousness never ends.

One educated at a modern university, might be able to discuss in psychological terms what makes men want to do things. Psychologists have a lot of fine words for things that we ordinary people still describe in shorter and sometimes more expressive terms. They say that a man was motivated by an inferiority complex, and was using an escape mechanism, when what they mean is that "he got fed up with life and went on a toot." The performance is the same old human way of doing things—only the words are dif-

ferent, but the man who knows what makes people want to do things, whether he is a psychologist or just has horse sense, has an advantage over his fellows because he can lead them. When you know how to give a man or group of men an incentive, you don't have to drive them. In fact, they will run you ragged finding better and more efficient ways of reaching their goal.

The classic incentive for increased output in industry used to be pay and some very elaborate schemes for tying a man's earnings to his output have been devised, and are still being used, but piecework can not be applied to every job. The first company that the writer worked for used a blanket form of incentive that was at the time revolutionary, and was responsible for building one of the great industrial empires of this country. Someone in that organization had read a little book, called, "Scientific Management," by Frederick Winslow Taylor. In it Taylor described some experiments that he had made to increase the work output of laborers who were piling pig iron. By offering the men a liberal increase in daily pay if they would do their work exactly as he directed, Taylor experimented with various combinations of work and rest periods, and with different ways of lifting and carrying, until he had nearly doubled the daily work performed, and the men admitted that they were less tired at the end of the day than they had been when they were accomplishing less.

Someone in the Ford Motor Company, probably Dean Marquis, head of the personnel department, then Henry's confidential advisor, must have read Taylor's book. Whoever it was did a good job of absorbing the principle that to lead men out of old behavior habits, they must be given an incentive. In 1913 Detroit was rocked as though by an earthquake with the news that the Ford Motor Company was at once going to increase its minimum pay for all men with six months seniority to the astounding figure of five dollars a day. At the same time working hours were cut to 48 a week. It took scores of police, and finally some fire hose streams to break up the mobs that tried to crash the employment office in Highland Park. To Henry's everlasting credit, be it said that with the pick of practically all the mechanics in Detroit at his plants, he never used this pay raise to clean out his old organization.

What use he made of it was never a matter of front page news, because it was more subtle and less dramatic. Using the incentive of the pay raise, Ford changed the way in which men worked, by constantly experimenting and timing operations, until he got the greatest output per man per machine. In some cases this involved complete changes in operations, but almost invariably with less physical work and with faster motions. The results are, of course, a matter of history. The assembly time on many units was cut in half. It was efficiency such as had never before been seen in industry, and it wasn't until the other automobile manufacturers adopted the same technique that they were able to catch up.

This may sound like a story about the making of automobiles, and, indeed, it is. It is, however, also a classic example of what can be accomplished by offering men an incentive sufficiently strong that they will submit to guidance, even in those things that they normally cherish as craft prerogatives. It worked without trouble just as long as the incentive lasted. Those who have followed Ford's later years of conflict with labor, know that when competition and the slowly stretching dollar caught up with the five dollars a day plan, the incentive was lost and trouble began for Ford, but while the incentive was there, Ford was absolute master of his empire.

The oil industry has this same incentive, as an industry perhaps, not as individual companies. Comparative studies have always shown that a man working for an oil company was better off financially at the end of the year, and at the end of his working life, than in almost any other industry one can name. As a result it has been possible to employ men who want to stay with the business, because they know they are in a line of work that is both enduring and profitable.

In addition to the pay incentive, the oil industry as a whole has given other benefits of tangible value, tending to provide security and contentment. All of which adds up to the conclusion that it should be possible in the petroleum industry to interest men in doing their work in a manner to improve the efficiency of operation, and provide for the safety of their fellow workers.

With all its advantages, the oil business should be the most efficient in the country, but this claim is not made. We buy the newest and most expensive machinery; we change our drilling, producing, and refining equipment as rapidly as new devices and processes are developed. During the war, the industry spent nearly a billion dollars for new and almost untried plants for producing aviation gasoline, and with tremendous success. And yet for the most part, we use methods of job training that are as obsolete as the mailpouch engine and shell still.

There is nothing so expensive as letting a man learn how to do a job by the trial and error method. No branch of the armed services would have had a man in the field in years if they had let the rookies learn that way. Even in our business, no engineer, geologist, chemist, or other scientifically trained man is allowed to repeat the mistakes and errors of his predecessors. At any given time, and for any given job, there is one best way of doing it, worked out by the experience of those who have gone before. Science is the art of discovering that best way, and so making the experience of others available. We are all expected to add something to what has been learned before, but it would be the worst kind of folly to expect us to repeat other people's mistakes. If that is good sense in engineering and science, why isn't it good sense in teaching a man to be a drilling or production employe?

Cy Delaney, who taught the writer what little he knows about field operations, used to plead for the chance to run a school for roughnecks, derrick men, and drillers, as part of the safety program. He never had his chance, and it is doubtful if there has ever been such a school. Field men, it appears, are still made the hard way, learning what they can from watching others who are a few months older at the game, perhaps, and proponents of methods that may or may not be right. The same can be said of almost every job in the oil fields. And it isn't because it is cheaper that way! The real cost of this casual training is tremendous, but unrecognizable because it is buried in drilling and lifting costs so that only a Houdini could find it.

Of course, Cy was wrong in trying to tie the training program on to the safety budget. That isn't where it belongs, but he was right in believing that if men are trained in the right way of doing a job, and are not allowed to develop bad habits of operation right from the start, we would hardly need to preach safety. For safety is a way of thinking about your job, and thinking can be made a matter of habit, if the process is begun when a man is first placed on a new job.

There have been some very successful training programs in other industries, and not a few in the sales, and even the refining departments of the oil industry, but by far the most successful work ever done in training wholly uneducated and green men was done by the armed forces during the last five years. Thousands and hundreds of thousands were taught the best way of doing jobs that they had never even seen before. Every known means of instruction and habit training was used. There are now available films and instruction pamphlets on every craft used in the services. Many of these would be as useful in training men for industry as they were for the Army and Navy. The men who prepared this material and who painstakingly worked out the methods of teaching are already back in industry. If the oil industry were to take advantage of this material and these men—these teachers—they could very quickly bring their training of men up

Streamlined towboat

Streett Towing Company has added a new towboat of striking design to its oil fleet. The boat, Havana Zephyr, is a 2000-hp. twin screw towboat, capable of pushing ten 10,000-bbl. barges, equal to more than 4,000,000 gal. of gasoline (15,000 tons). Functional design is combined with pleasing appearance. It will push petroleum products from Baton Rouge, Louisiana, to Havana, Illinois.

to the high plane that they have achieved in the design of machinery and equipment.

There is nothing a man wants more than to be considered an expert in his job, and that applies all the way from the greenest roughneck up to the rare atmosphere of the executive circle. Here in the oil business, we have men who want to stay with the oil game, and in every decent company they expect to stay with the first outfit that hires them. How can we best satisfy this ambition? By turning him loose with a group of men who have specific jobs to do, and no time or patience for a novice? By letting him get hurt, or risk the safety of the entire crew because of his ignorance? "Well," as the tenderfoot said when the bronco kicked him over the fence, "there are several ways of getting here."

Safety can be ingrained in ways that are cheaper, and a lot less painful. A good premise to begin with is that a man should not try to learn and produce at the same time. Tackle two full time jobs at once, and you can't do justice to either. Whatever learning a job requires can be done much better if the man be allowed to concentrate on what he is learning, and not be permitted to divide his interest. Of course, added skill on any job comes from practice, and no graduate of a training class is an expert, but he gets something from a training school that no man has to begin with in the school of hard knocks—that is, a complete picture of what his job is, and how it may best be done. In that, he should be given a training period under a competent teacher, who will tell him, show him, let him try, and then correct his efforts until the correct way becomes a habit. That is all there is to training, once the material of the course has been properly set up. It may take a week, a month, or three months, depending on what kind of a job is being taught, but however long it takes, it is still not only worthwhile, but better than any other method so far devised.

Toolpushers talk of the drillers who work for them—some are old hands and some are very new. Most toolpushers and foremen know that their job has to be a teaching job—taking the neophytes and making competent workers out of them. Some do a fair job of teaching, but to the extent that they are trying to develop their men, they are taking time and attention from their main function —making hole and producing oil. That brings up the question: Is it smart or efficient to throw the burden of teaching on the man who is responsible for getting the work done? Wouldn't it be cheaper, and a lot more efficient, to have the candidates for drilling jobs trained by someone whose sole responsibility is to teach—not to make hole? No one would pick a school teacher as a toolpusher, so why expect a driller, toolpusher, or any other supervisor, to be a competent teacher? Experience has shown that often the best craftsmen are the poorest teachers.

This may seem an unorthodox approach to safety, but safety in the oil industry has taken a sort of evangelical turn, and safety engineers are supposed to do by preaching what supervisors have failed to do by teaching. That has never worked successfully because, philosophically, it is wrong. Safety on the job is a way of thinking, and thinking is a matter of habit. Habits are formed only while a job is being learned. Then is the most impressionable period in a man's life, and it recurs every time he learns a new job, whether it is as a roughneck or president of an oil company. For a few short days, only, indeed, until his self-confidence has again asserted itself, a man new on the job is really willing to learn. If during that brief period he is shown the best way to do his job, he will never have to unlearn bad habits. Nor will it ever be necessary to preach safety to him, because the best way of doing a job is always the safe way.

Millions of dollars are spent for research laboratories, where highly trained chemists and physicists spend their lives, searching out the answers to the technical problems of the petroleum industry. The foresight that founded these great institutions is not wasted. The day by day product of any individual on the research staff may be difficult to measure, but of the benefit derived from the total effort there can be no doubt.

The present generation may not live to see it, for the mind of man is slow to move, but the time will come when ordinary workmen will become just as much the consideration of research as are the products and processes of today. Ask any executive what item, barring taxes, looms largest in the budget, and he will tell you—payroll, the cost of labor. Yet more money has been spent on chemistry and physics than has ever been spent in learning how to train men in the art of productive, safe operation.

There is need of every kind of research in the oil business, product research, public relations research, and many other types, but we must not overlook that human research for which we seem to be so peculiarly ready at the present time. We have men of high quality. We have an understanding and far-sighted management. We have the technical knowledge. Why not, then, launch some researchers on the human factor in this great machine of ours, the measurement of human aptitudes, the evaluation of human traits and characteristics, in short, such tests and investigations as will enable us to utilize the worker, our most expensive and most important unit, in the most effective and mutually satisfactory manner. From such studies should come the ultimate in teaching methods, and the best of teachers, to shape the minds of new men in operational ways that are more productive, safer, and better in every way for all concerned. When that job in human research has been advanced as capably as have the technical projects, we safety engineers may have to back out of the petroleum picture—but we will do so gracefully, and with a measure of genuine satisfaction. ★★★

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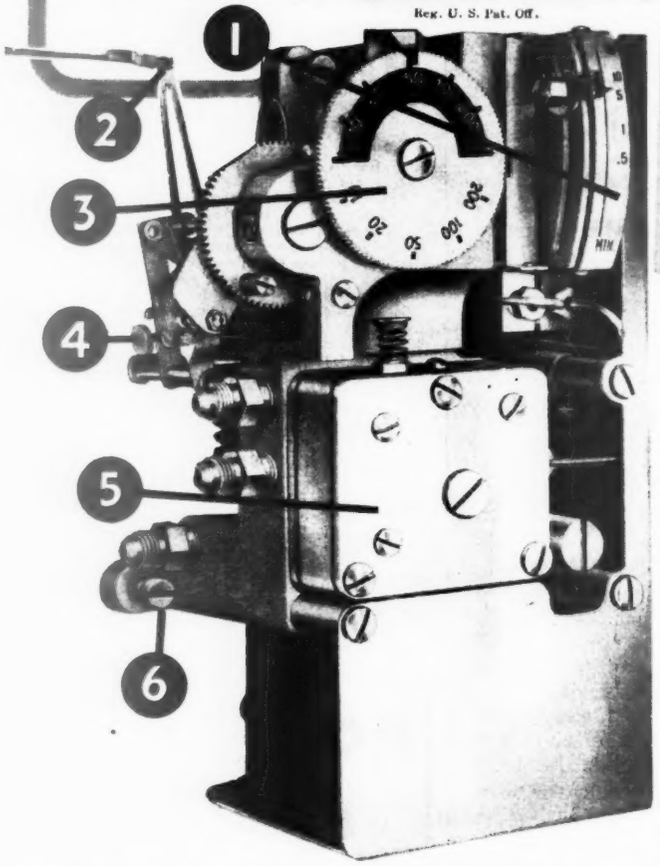

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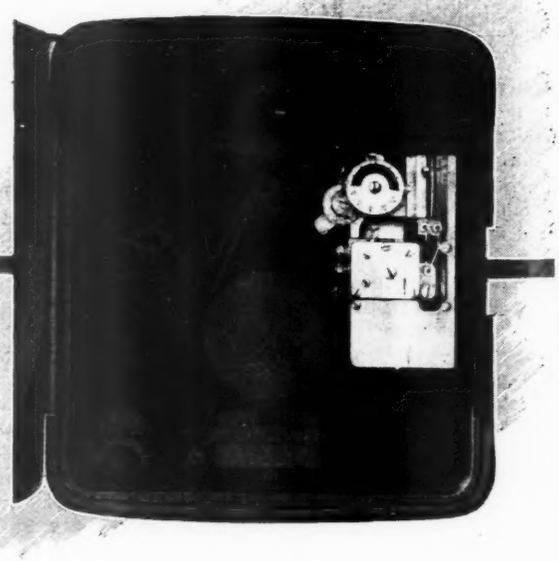

THE NEW

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Unit built specially to use new catalyst

BREAKING-IN operations have started on the Shell Oil Company's new catalytic cracking plant at Houston, Texas. The huge unit is the first plant of its kind in the world built specifically to use the newly developed micro-spheroidal catalyst. At full-scale operation it will process more than 20,000 bbl. of charging stock daily.

Besides high octane motor fuel, the plant will produce burning oil distillates, light fractions for use in alkylation, chemicals and butadiene, and other petroleum products. Begun in the spring of 1945, and wholly financed by the company, the "cat cracker" was originally intended to serve as part of Shell's wartime aviation gasoline program, company officials stated, but now will concentrate on improved gasoline for civilian use.

The plant's gigantic size is revealed in statistics released by the company. Its cooling water system has a pumping capacity of sufficient size to supply a city of 150,000 people. Its electrical requirements are equal to the consumption of a city of 20,000 to 25,000 people. A special railroad built into the plant site carried about 1500 carloads of materials for use in construction. Approximately 1500 men were employed on the project at the peak of building activity.

The plant includes not only the catalytic cracker proper, but also a number of auxiliary plants, such as gas recovery, fractionating and treating units, a feed preparation plant, and a vast amount of tankage. The sprawling new project occupies a site comprising about 75 acres of a 650-acre plot recently purchased by Shell adjoining its present refinery in Houston.

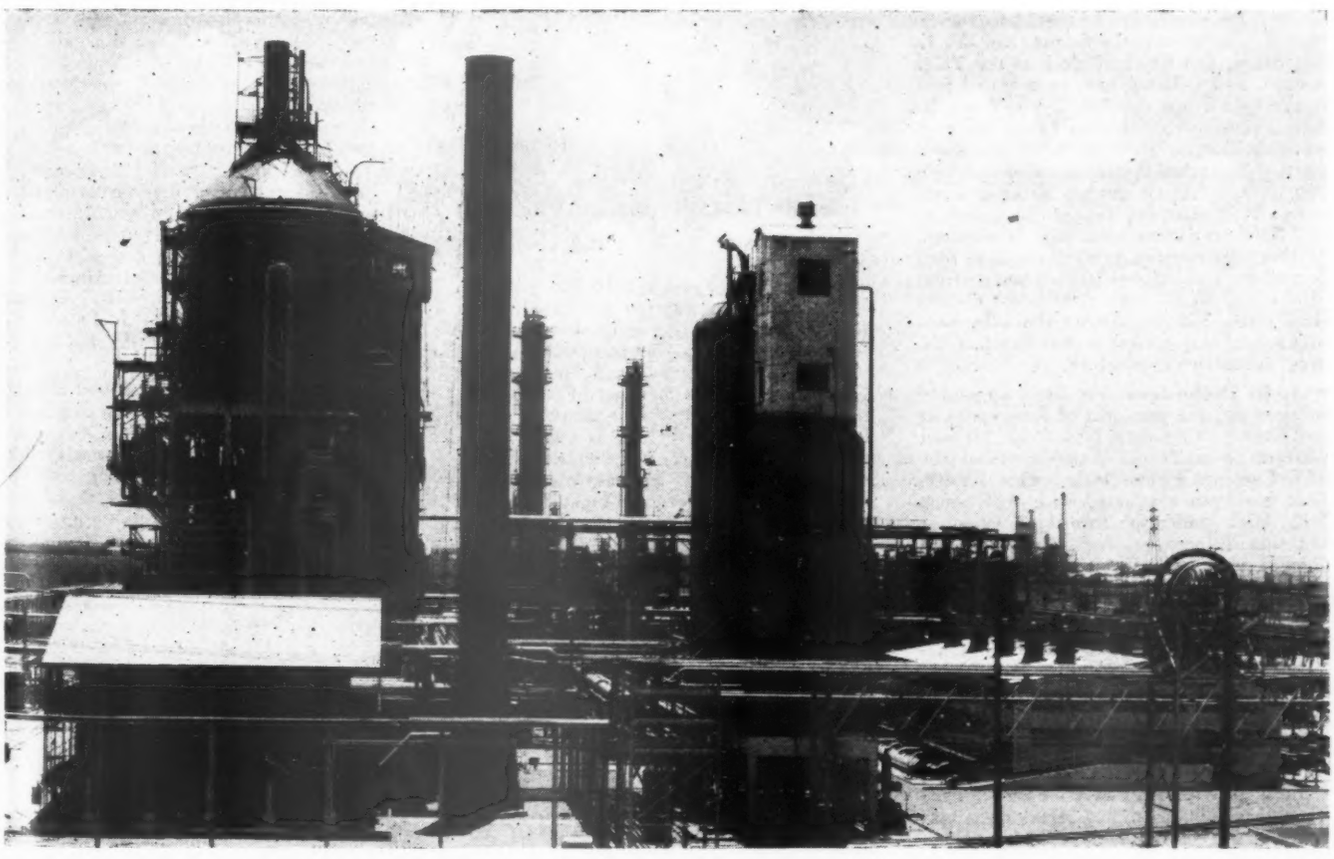
The new micro-spheroidal catalyst is more fluid than catalysts normally used, company spokesmen said. Because of the spheroidal shape of its particles, it will not break up as rapidly as catalysts having irregularly-shaped particles, and consequently will have a longer life, they added.

In planning the project, engineers gave special consideration to ease of maintenance, convenience of operation, and comfort of employes. Automatic control devices are used wherever possible. Control rooms are completely air-conditioned, and have tile walls and terrazzo floors. The color scheme was planned to make surroundings pleasant and to limit eye strain and fatigue.

In addition, the plant will be more convenient to operate and maintain because its total height is about 40 ft. less than in conventional catalytic cracking units, the company reported. This was made possible, spokesmen said, by the unusual nature of the new catalyst and by numerous innovations in mechanical design.

Major contractors were Foster Wheeler Corporation, New York, on the "cat cracker" proper, C. F. Braun and Company, Alhambra, California, on the gas plants, and The Fluor Corporation, Ltd., Los Angeles, California, on the feed preparation unit and auxiliaries. ★ ★ ★

The Shell Oil Company's new catalytic cracking plant at Houston, Texas, the first plant of its kind in the world built specifically to use the newly developed micro-spheroidal catalyst. The "cat" cracker and auxiliary plants occupy about 75 acres of a 650-acre plot recently purchased by Shell adjoining its refinery.



Running Tour WITH MEN IN THE INDUSTRY

• **J. C. "Jack" Barcklow** has returned to active practice of geology after spending the last 5½ years with the Lane-Wells Company, in the technical oil field service as Mid-Continent division sales manager, and more recently as research geologist at Dallas. His headquarters are in the First National Building, Ada, Oklahoma. Prior to his connection with the Lane-Wells Company, he spent 16 years as a geologist in the Mid-Continent area of the United States, with Carter Oil Company, Skelly Oil Company, and Deep Rock Oil Corporation.

J. C. "Jack" Barcklow

• **M. L. Mayfield** and **Louis I. Mistrot** have recently formed the Production Engineering Service Company with offices in the Esperson Building, Houston, Texas. It is their plan to offer field reservoir studies and specialize in complete production engineering services.

• **R. P. "Salty" Clark,** vice president of Lucey Products Corporation, has just returned to his Tulsa office from an extended trip to the various fields of Venezuela and Colombia. Clark is a member of the Tulsa chapter of Nomads.

• **J. V. Blacklock,** assistant division chief clerk of the East Texas division of Humble Oil and Refining Company, has been transferred to the production operating department in the Houston office as policy and organization coordinator. **N. B. Robins,** assistant division chief clerk of the Louisiana division, New Orleans, Louisiana, and **W. E. Kirkham,** district chief clerk of the Talco district, Talco, Texas, have been transferred to the East Texas division, Tyler, Texas, as acting division chief clerks. **Clark Garner,** assistant district chief clerk of the Talco district, Talco, has been promoted to acting district chief clerk during Kirkham's absence. **T. M. Roper,** district chief clerk of the Natchez district, Natchez, Mississippi, has been transferred to the Louisiana division office, New Orleans, as assistant division chief clerk. **E. E. Setser,** assistant district chief clerk, Paradis district, Paradis, Louisiana, was transferred to the Natchez district, as district chief clerk.

• **J. L. Onderdonk** has been appointed an assistant vice president of American Car and Foundry Company, New York. He will continue to make his headquarters at the ACF Chicago, Illinois, sales office. Onderdonk has been associated with ACF since 1912. After graduation from high school at Evanston, Illinois, he went to work for the Chicago and North Western Railway in its stores department and was for some years district storekeeper at Clinton, Iowa. For a short period in 1911 he was associated with American Steel Foundries, prior to going with ACF.

• **L. D. McNeill** has been appointed store manager of the Houston branch of The Continental Supply Company. Mc Neill succeeds **R. L. Pebworth** who has resigned.

• **George G. Deverall** of Passaic, New Jersey, has been appointed sales representative of New York Belting and Packing Company in New England, New York, New Jersey, and eastern Pennsylvania. Deverall enlisted in the Army in 1940 and recently went on inactive status with the rank of colonel after a tour of duty in Australia, West Indies, Okinawa, Japan and other Pacific bases. He will make his sales headquarters at the company's plant in Passaic, where he had been employed for 15 years previous to his military service.

• **Emil G. Holmberg** has been appointed consulting metallurgist for Alloy Steel Products Company, Linden, New Jersey. Holmberg, a graduate of the Colorado School of Mines, for a number of years was research metallurgist specializing in corrosion problems at the Belle, West Virginia, plant of E. I. duPont deNemours and Company, Inc.

• **Harold L. Severance** has been elected an assistant secretary of the Standard Oil Company of California. Severance was graduated from Stanford University in 1932 and went to work for Standard the following year in the Richmond refinery. Subsequently he served on the accounting staff of the manufacturing department. He was attached to the secretary's office in 1940.

• **J. H. Ihrig** has been appointed resident manager of Bethlehem Supply's new sales office in Denver, Colorado. Ihrig is well known in the oil fraternity and supply business. He is one of Bethlehem's oldest employes from the standpoint of service. His employment dates back to 1922 when he became affiliated with the International Supply Company and continued with Bethlehem

J. H. Ihrig

E. S. Lewis

when that company acquired International. When Bethlehem entered the Illinois field in 1939 Ihrig was placed in charge as district manager and continued in that capacity until his present promotion. **E. S. Lewis** has been named district manager of Illinois district succeeding Ihrig. Lewis joined the Bethlehem organization in 1943 as a field representative. He was later promoted to store manager and then to assistant district manager. His headquarters will be at Salem and he will maintain his residence at Mt. Vernon.

• **Ernest S. Theiss** has been appointed assistant chief engineer of the Davey Compressor Company, Kent, Ohio. For the last seven years, Theiss has served as assistant professor, mechanical engineering department, College of Engineering, Duke University. He graduated from Case School of Applied Science in 1932 and received his master's degree from that university in 1939.

• **Robert L. Whiting** has joined the staff of the Petroleum Engineering Department at Texas A. & M. College as associate professor. Whiting goes to A. & M. from the Missouri School of Mines, Rolla, Missouri, where he held the position of associate professor of petroleum engineering during the school year, 1945-1946. Whiting has served as instructor of petroleum engineering at the University of Texas, Austin, Texas. He has been employed by the Sinclair Oil and Refining Company at Houston, Texas, as foreman, the Railroad Commission of Texas, Pampa, Texas, as natural gas engineer, and then by the Stanolind Oil and Gas Company in various engineering capacities.

• **P. M. "Pat" Holden,** general manager of stores and retail sales for the Geo. E. Failing Supply Company of Enid, Oklahoma, and Houston and Midland, Texas, was killed in an airplane accident on August 21 near the Enid airport. Holden had been associated with the company for 12 years and was well known among members of the drilling industry. He was the son-in-law of George E. Failing. He is survived by his widow and three children.

• **Paul Shuman,** treasurer and member of the board of directors of The Atlantic Refining Company, died August 22 at his home, Jaffrey Road, Malvern, Pennsylvania. He was 62. Born in Philadelphia, Shuman was a graduate of Girard College and of the University of Pennsylvania's Wharton School. He joined the Accounting Department of The Atlantic Refining Company in June, 1920, and was named assistant treasurer in March, 1929. He was named treasurer in May, 1937, and was elected to the board of directors in September, 1939.

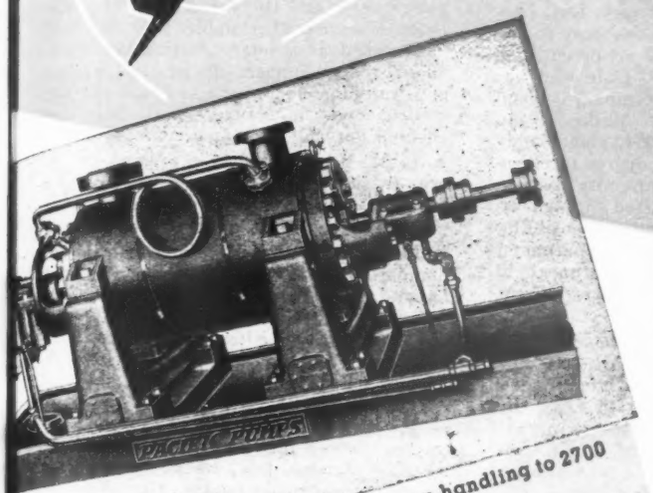
• **James K. Ellis,** vice president and general superintendent of production for Transwestern Oil Company, San Antonio, has been named vice president and general superintendent of production for the Sunray Oil Corporation, Tulsa, Oklahoma, following the merger of Transwestern with Sunray. Ellis succeeds **Harry H. Mack,** who will continue as a vice president. Ellis joined Transwestern in 1937 as general superintendent of production, and in 1940 was named a vice president and director. Although most of the Transwestern records and a few of the personnel will be transferred to Sunray's Tulsa headquarters, a division exploration office will be maintained in San Antonio by Sunray. The supervisory staff will include **Don O. Chapell,** division geologist; **F. E. Swenson,** division landman; **Marion Jo Moore,** geologist and geophysicist; **Wilford Stapp,** geologist; **William J. Lance,** engineer and draftsman, and **C. F. McCarroll,** gas engineer.

• **H. H. Anderson,** vice president of Shell Pipe Line Corporation, Houston, Texas, has been named chairman of a committee organized by American industries to assist them in handling problems arising from soil corrosion to underground structures. Anderson was named in St. Louis at a meeting of representatives of Association of American Railroads, American Gas Association, American Petroleum Institute, American Water Works Association, Bell System, The Western Union Telegraph Company, and National Association of Corrosion Engineers. The committee—Correlating Committee on

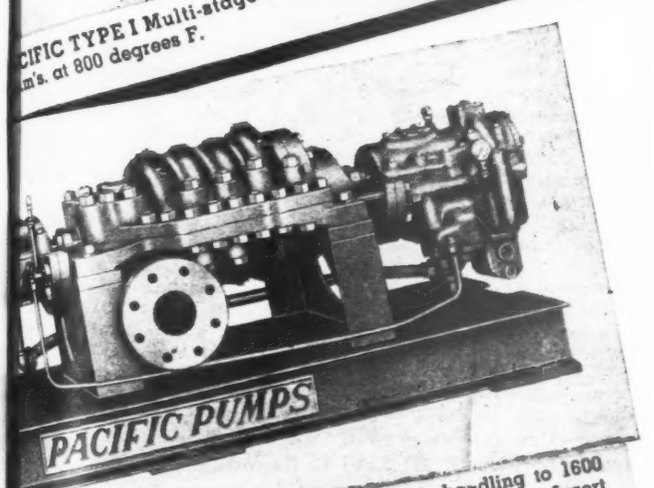
H. H. Anderson

Pacific

designs and builds the correct types of pumps for all fluid handling needs of the petroleum industry



CIFIC TYPE I Multi-stage Centrifugal Pump handling to 2700
m's. at 800 degrees F.



IC TYPE J B Multi-stage Centrifugal Pump handling to 1600
s. at 500 degrees F. (Right) Pacific Rod Sectional Liner Insert
Oil Well Pump.

35

Pacific Deep Oilwell Plunger Pumps are "Precision Engineered," to meet the most exacting problems encountered in all types of fields and at all pumping depths.

An outstanding feature in these pumps is "Moloy," a special Molybdenum Alloy developed by Pacific Engineers, for the manufacture of Pacific Liners and Plungers.

A foremost fact about Pacific Deep Well Oilwell Plunger Pumps is that liners and plungers may be reground three and four times. Pacific's regrinding service enables the operator to go to his "scrap pile" for increased profits.

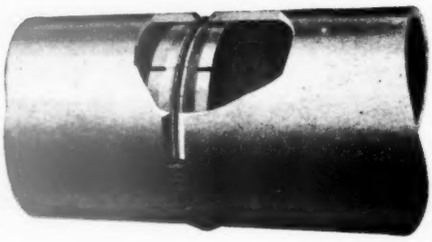
In the Centrifugal Pumping Field, Pacific's complete line of Centrifugal Pumps are made in styles and sizes to meet practically every need for this type of pump in refining, power and general industrial plants.

PACIFIC PUMPS INC., Huntington Park, Calif.
One of the Dresser Industries
Export Office: Chanin Bldg., 122 E. 42nd St., N. Y.

-CONTINENT DIVISION
E. 2nd Street, Tulsa, Okla.

PACIFIC *Engineered* PUMPS

Engineers for pipelines and refineries find that the WEDGE Chill Ring with the patented SPLIT Feature is FAR ahead: there is no other welding method that compares with it. This new and better way of welding RE-INFORCES every joint, making the joints the strongest part of the line. Permits SAFE use of LIGHTER pipe . . . decreasing weight and cost.



Pipelines can be laid faster with WEDGE Chill Rings. In case of shock, strain or vibration the pipe will fail before the reinforced joints. Why not investigate this BETTER and FASTER way of welding?

Write for Information

WEDGE PROTECTORS, INC.

3977 Jennings Road, Cleveland 9, Ohio

WEDGE
Split CHILL RINGS
SAVE MONEY

Cathodic Protection—will undertake a program of education and assistance to interested industries by preparation of technical information on improving procedures for handling inter-line problems arising from cathodic protection of pipe lines, communication cables, railroad signal systems, and other buried metal structures. The St. Louis meeting was initiated by the pipe line transportation group in the American Petroleum Institute.

• **Reid W. Bond** has been appointed to a newly created post of production director of Shell Oil Company's exploration and production activities east of the Rockies. His office will be in Houston, Texas. Bond has just returned from the Army. At the time of his release from service, he held the rank of Colonel. Bond, a graduate of the University of Pittsburgh Mining Engineering School, was production manager for the company's Mid-Continent area at the time of his entry into the service in March, 1942. He has had 21 years' experience with Shell.

Reid W. Bond

• **Dr. P. J. Merkus, Jr.,** until recently manager of the research and development department, Shell Oil Company, Inc., New York, has been appointed assistant to the vice president in charge of manufacturing. Dr. Merkus succeeds **H. D. Dale** who was appointed manager of the company's Wood River, Illinois, refinery. Dr. Merkus began his career with Shell in 1934, immediately after receiving his doctor's degree in chemical engineering from the University of Michigan. Thereafter, he progressed through various positions of increasing responsibility in the research and development department, becoming manager of the department in 1943, a position he held until his present appointment.

F. C. Cutting, assistant manager of the research and development department, succeeds Dr. Merkus as manager. Since joining Shell in 1925, after graduation from the University of Michigan, he has advanced through various technical and administrative positions at the company's refineries, as well as in the New York office.

Roy W. Faulk, former assistant superintendent at the Norco refinery, has been named assistant superintendent at the company's Houston refinery. He will be in charge of the topping, cracking and dispatching departments. After graduating from Southwestern Louisiana Institute in 1939 with a degree in chemical engineering, Faulk commenced work with Shell as a tester in the Houston laboratory. He rose rapidly through the administrative and operating departments of the company's refineries, and returns to Houston after an absence of ten years.

John B. Dunlap, manager of the cracking department at the Houston refinery, succeeds Faulk as assistant superintendent at Norco. Dunlap graduated from the University of South Dakota in 1928 with a degree in chemistry, and immediately joined Shell as a gauger in the Arkansas City refinery. During the following twelve years, he gained experience in the company's refineries until, in 1942, he was appointed manager of the cracking department at the Houston refinery.

• **L. L. Mitchell** has been appointed assistant treasurer and assistant general credit manager of Oil Well Supply Company, with headquarters in Dallas, Texas, where executive offices of the company are situated. A native of Lubbock, Texas, and graduate of Oklahoma A. & M. College, Mitchell joined Oilwell Supply in 1940 and has served at company offices in Los Angeles, California, Oil City, Pennsylvania, and Columbus, Ohio.

• **Norman S. McCausland,** for 17 years assistant treasurer of The Atlantic Refining Company, has been elected to the board of directors and named treasurer of the company to take the place of Paul Shuman, who died recently. McCausland entered Atlantic's employ in 1917, as secretary to the treasurer. In 1929 he moved to the post he held until his new appointment.

• **T. S. Scibienski** and **John F. Lynch,** who have been with La Gloria Corporation, Corpus Christi, Texas, for the last two years, recently were elected vice presidents. Lynch also represents La Gloria Corporation as a director on the board of Carthage Hydrocol, Inc. of New York. **John J. Sheerin** has resigned as vice president but will continue as a director, and **E. C. Will,** who also resigned as vice president, will remain with the company as a consultant.

• **C. A. Ross** has been appointed manager of the Graham, Texas, store of The Continental Supply Company. Ross, formerly serving as salesman at Odessa, Texas, succeeds **Jack M. Brown,** who has resigned.

• **A. M. Orr,** assistant district superintendent for Humble Oil and Refining Company's Stratton district, has been promoted to the post of district superintendent of the company's Scott and Hopper district. Orr, who entered service of Humble July 20, 1919, has worked as a rotary derrickman, roustabout, rotary fireman, driller, tool pusher, and was promoted to the assistant superintendent's post in May, 1945. He held that position until his present promotion.

• **C. M. Wittum** has been appointed eastern division credit manager for Oil Well Supply Company. Eastern division offices of the company are in Columbus, Ohio.

• **Dr. F. M. Rogers,** chief chemist at Standard Oil Company (Indiana) Whiting Laboratories retired September 1. He joined Standard Oil from the United States Geological Survey in 1903, after receiving his Ph.D. from Johns Hopkins University in 1907. In 1914 Rogers became chief chemist and was responsible for all the work of the research laboratories for a number of years. Dr. Rogers was honored at a farewell dinner in Whiting. The principal talk, describing Dr. Rogers' work, was made by **Dr. Humphreys,** former vice president in charge of manufacturing. Other speakers were **T. H. Rogers,** associate director of research, and **J. K. Roberts,** general manager of research.

J. O. Dorroh

• **J. O. Dorroh** has been appointed manager of the Gulf Coast Division of The Hinderliter Tool Company. His headquarters will be in Houston, Texas. Dorroh for the last 21 years has been with the Wilson Supply Company. The Hinderliter Tool Company, Tulsa, Oklahoma, a subsidiary of the H. K. Porter Company, Inc., manufactures wellhead equipment in all pressures, tool joints, cable and fishing tools.

• **Michael L. Benedum,** president of Benedum-Trees Oil Company and controlling factor in a number of oil producing, refining, and pipe line companies, has accepted appointment as an honorary trustee of Marietta College, officials of this institution have announced. Benedum, who as a boy grew up

in near-by **Bridgeport, West Virginia,** rose from obscurity to become known as "the world's No. 1 oil wildcatter." During 56 years in the oil business, he has developed many famous fields in the United States, Mexico, Rumania, South America, and other nations. As honorary trustee of Marietta College, he will have an opportunity to help decide policies for the new Edwy R. Brown School of Petroleum, opened in the fall of 1945. This school was founded by a bequest of $300,000 from E. R. Brown, former vice president of the Socony-Vacuum Oil Company.

• **C. A. Pollard** has been appointed assistant general manager of the Richmond refinery of Standard of California. A Standard Oiler since 1921, Pollard has been at the Richmond refinery for the last 16 years, most recently as manager of the refining division. **C. W. Rehfuss,** manager of service divisions at Richmond, becomes manager of the refining divisions. Rehfuss has been with the company for 22 years.

• **John E. Miller** has been appointed machinery service manager, general sales department, of Oil Well Supply Company, Dallas, Texas. A native of Glen Campbell, Pennsylvania, and a graduate of Penn State College, Miller started with Oil Well Supply as a student engineer in 1933. He served for several years as a field engineer at McPherson, Kansas, and Casper, Wyoming, and was a sales engineer at Okotoks, Canada, for four years.

• **Alexander Anderson,** and Mrs. Anderson, who have spent some time in Edinburgh, Scotland, are returning to residence in the United States. They expect to land at San Pedro, California, about October 5, and will make their home in Fullerton, California.

• **Frank H. Stone** has recently been appointed superintendent of La Gloria Corporation's cycling plant at Falfurrias, Texas. He was formerly resident engineer at this plant.

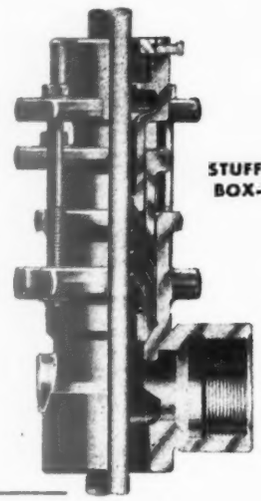
• **Edward B. Heyden** has been named to head the construction division of the Graver Tank and Manufacturing Company, Inc. Active in construction work since 1920, Heyden has been associated with The Lummus Company for the past 14 years. He replaces **Lloyd K. Wells,** who is retiring to follow personal interests on the West Coast.

• **John E. Fogarty** has been appointed to the post of general manager of the plant at Sand Springs, Oklahoma, for Graver Tank and Manufacturing Company, Inc. He formerly managed the Graver weldment division at the main plant in East Chicago, Indiana. Storage tanks and other fabricated plate products are manufactured at the Sand Springs plant.

• **S. W. McGaha** and **V. J. Mercier,** of Lane-Wells Company, Oklahoma City, Oklahoma, and Wichita, Kansas, respectively, will speak on "Well Logging by Radioactivity" before the Kansas Society of Petroleum Engineers at its meeting September 26 in Ellinwood. **H. E. Allen** is chairman and **P. R. Waddle,** secretary-treasurer, of the society. Both are with The Carter Oil Company, Great Bend.

• **P. M. Dinkins** has been made president and a director of Jefferson Chemical Company, Inc. Jefferson Chemical was organized in November, 1944, by American Cyanamid Company and The Texas Company to produce chemicals from petroleum and petroleum gases. Its first plant, now under construction at Port Neches, Texas, will produce intermediate chemicals used in the rubber, plastics, textile, and other industries.

FULLY PATENTED

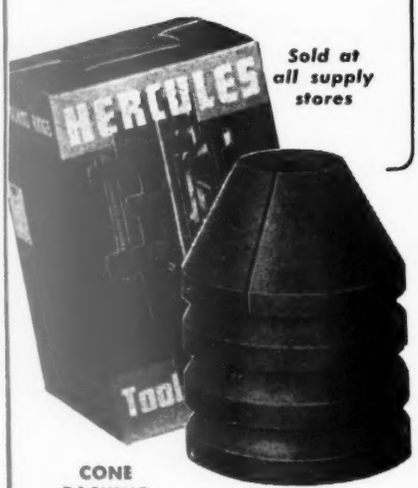


STUFFING BOX-TEE

NO DETOURS

On the 'CONE PACKED' job!

In actual fields of operation, Hercules' exclusive "Cone Packing" has proved to be a time saver, as it practically eliminates friction . . . will not burn out or leak if well pumps off. This takes no account of time lost in repacking the ordinary box. Cone Packing has successfully withstood over 2,000 pounds pressure, and more important, will outlast old-style ordinary packing many times. Let Hercules Cone Packing prove its ability to meet your most exacting requirements!



Sold at all supply stores

CONE PACKING

HERCULES TOOL COMPANY

TULSA, OKLAHOMA, Box 286

EXPORT OFFICE: 30 Rockefeller Plaza

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CABLE ADDRESS: HERTOCO

LAUGH WITH BARNEY

Golf is a game where a ball 1½ inches in diameter is placed on another ball 8,000 miles in diameter.

The object is to hit the small ball, but not the large one.

If the folks who design bathing suits aren't careful, they'll be working themselves out of a job.

Junior: Pop, when I bring home my report card, why do you always sign it with an X instead of writing your name?

Father: I don't want your teacher to think that anyone who can read and write would have a son as dumb as you.

"How much for that hat?"

"Seventy-five dollars."

"Where are the holes?"

"What holes?"

"Why, the holes for the ears of a jackass that would pay seventy-five dollars for that hat."

Farmer: You can't go wrong on this mare, sir. She's sound, gentle, a good worker and a fine saddle horse.

City Slicker: What I want to know, is she tender?

Young man who gets paid on Monday and is broke by Wednesday would like to exchange small loans with someone who gets paid on Wednesday and is broke by Monday.

Telegraph Messenger: What was the most wonderful experience you've ever had?

Another T. M.: The night I took a telegram to a beautiful blonde saying her husband wouldn't be home until the next day.

Lazy Husband: I see there's talk of another strike.

Wife: Yes, and if you was 'arf a man you'd get a job an' be able to go on strike, too.

Doctor: Say "ah."

Patient: I didn't come here for an examination, I just want to pay my bill.

Doctor: "Ah-h-h."

Fond Mother: Now, Junior, dear, what will you say at the party when you've had enough to eat?

Junior: Goodbye!

A woman finally found she could get a divorce from her husband because of his flat feet. His feet were in the wrong flat.

Love is when she sinks in his arms and ends with her arms in his sink.

A man with a little black bag knocked at the front door.

"Come in, sir, come in," said the father of fourteen children, "and I hope to goodness you're a piano tuner."

"It's a bottle of hair tonic, dear.

"Oh, that's very nice of you, darling."

"Yes, I want you to give it to your secretary at the office. Her hair is coming out rather badly on your coat."

Blondie: Do you know what they're saying about me?

Pete: Why do you suppose I came over to see you?

Little Boy: What makes the traffic light turn red?

Friend: You would too, if you had to stop and go on every corner!

Lola: Listen girlie, the sailors run after my kisses.

Dottie: Yeah? After mine they limp.

CEILING PRICES

Chili	15c
Chili in a bowl	20c
Chili in a bowl with crackers	25c
Chili in a bowl with crackers, spoon, and glass of water	30c

"My, my, how on earth did you come to get so completely intoxicated?" asked the magistrate.

"I got in bad company, your Honor. You see, there were four of us. I had a bottle of whiskey, and the other three didn't touch the stuff."

We envy the Hollywood janitor whose salary includes room and board and any little extras he can pick up.

Vacationist: Any big men born here?

Native: Nope. Not very progressive 'round here: best we can do is babies. Diff'rent in the city, I s'pose.

"Shoe shine, mister?"

"No."

"Shine 'em so you can see your face in 'em."

"I said no."

"Coward!"

Father: Johnny, what makes you skip school all the time?

Johnny: Class hatred.

The inspector was paying a hurried visit to a slightly over-crowded school.

"Any abnormal children in your class?" he inquired of one harassed-looking teacher.

"Yes," she replied, with knitted brow, "two of them have good manners."

A hillbilly edged up to the ticket window.

"Mister," he said, "I aim to go to New York to fiddle in Zeb Stewart's Kentucky Band. Can you fix me up for to go there?"

"Certainly," replied the agent, "the fast flyer goes through here in about five minutes and I can flag her for you—but what about your trunk?"

"Trunk?" asked the puzzled mountaineer. "What's a trunk for?"

"To put your clothes in," replied the agent.

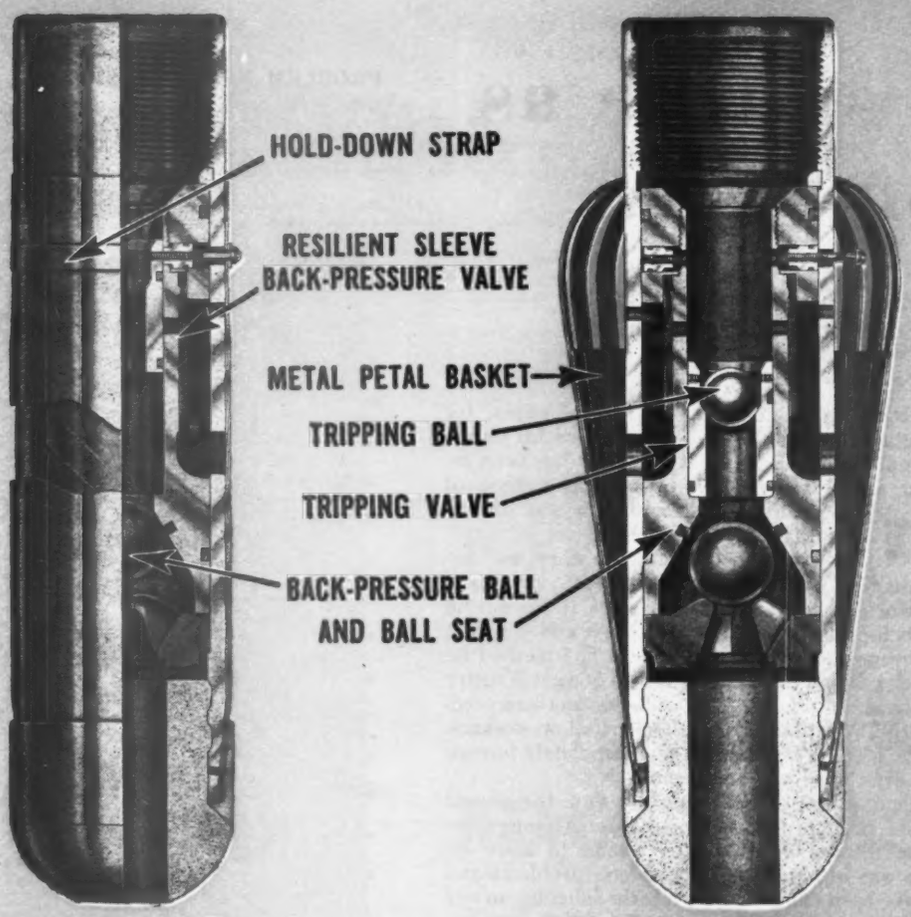
"What!" cried the scandalized hillbilly, "and me go nekked!"

Butcher: "I can't give you any more credit, sir. Your bill is bigger now than it should be."

Customer: "I know it. Make it what it should be, and I'll pay it."

"Do insects ever get in your corn, Farmer Jones?"

"Yep, but we just fish 'em out and drink it, anyway."



THE BAKER *Triplex* CEMENTING SHOE does an important job...and does it well!

The "Triple" purpose of the Baker TRIPLEX Cementing Shoe is to pack-off in large-diameter, or irregularly-shaped holes, retain all cement slurry above the shoe, and protect permeable, low-pressure formations below from cement contamination.

All cement slurry is directed upward through side whirler ports. A sleeve-type, resilient rubber back-pressure valve opens readily to permit passage of the slurry into the annulus around the shoe, but closes instantly to prevent any return flow of slurry. The Baker Metal Petal Basket is intended to form a bridge, thus preventing cement slurry from settling into permeable, low-pressure zones below. The Basket is indispensable in large-diameter, or irregular-shaped holes.

The Baker TRIPLEX Cementing Shoe (Product No. 136) operates as a conventional float shoe while running-in the casing. Then, after reaching the desired point in the hole, circulation is established through the ample interior passageway of the shoe, and the hole is conditioned preparatory to cementing. The Tripping Ball now is pumped (or allowed to gravitate) down the hole to seat upon the Tripping Valve. A pressure of 400 to 500 psi is applied to the casing which shears the screws in the Tripping Valve, permitting it to move downward and expose the cementing ports. Shearing these screws also releases the hold-down strap around the basket, allowing the basket to expand outwardly against the wall of the hole. The cementing operation is then carried out in the conventional manner with all cement slurry directed upward and held above the shoe by the expanded Baker Metal Petal Basket.

The Baker TRIPLEX Cementing Shoe consists of a whirler float shoe with a Baker Metal Petal Basket fastened on the shoe below the cementing ports. All internal parts are made of readily drillable materials. Two one-half inch set screws hold the inner assembly stationary to facilitate drilling out the shoe.

Contact your nearest Baker office or representative for details and recommendations.

BAKER OIL TOOLS

BAKER OIL TOOLS, INC., LOS ANGELES • HOUSTON • NEW YORK

The square as a computer

By **W. F. MARTIN,**
Texoma Natural Gas Company

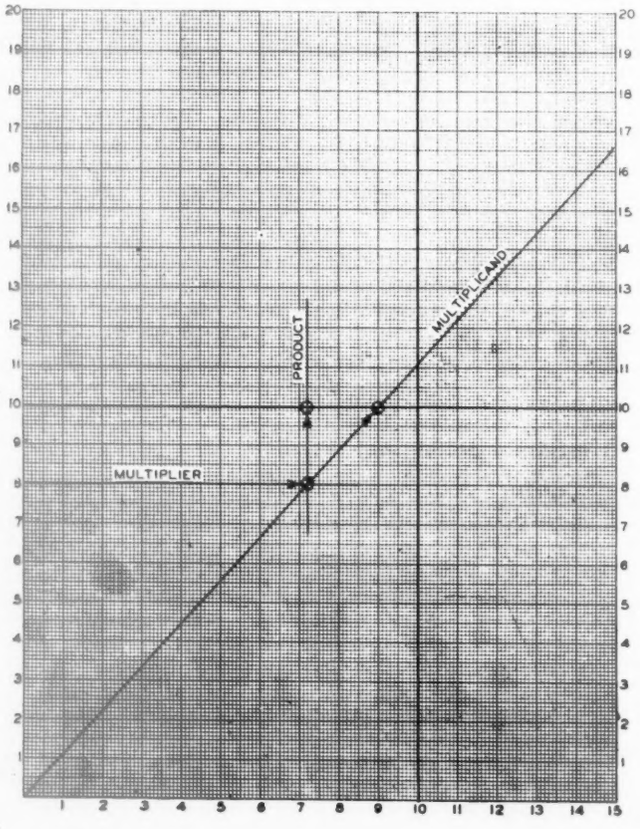
THE writer has used the square, or coordinate paper, for numerous computations. It is the basis for most of his charts prepared for computations of a special nature. It has been assumed that most people were familiar with this method of computation, but recently it was discovered that this assumption was in error. The writer is not at all sure when, and under what circumstances, he first used the method under discussion, but it was probably between 1910 and 1914. It was during that period when he was required to distribute and transmit braking power by means of rods and levers. The method he used then has been used on problems of the oil and gas industry since he joined that industry in 1920, but he has not had occasion, until recently, to explain his method to fellow workers. It was then that he learned this method was completely foreign to most people, even graduate engineers.

EXCLUSIVE

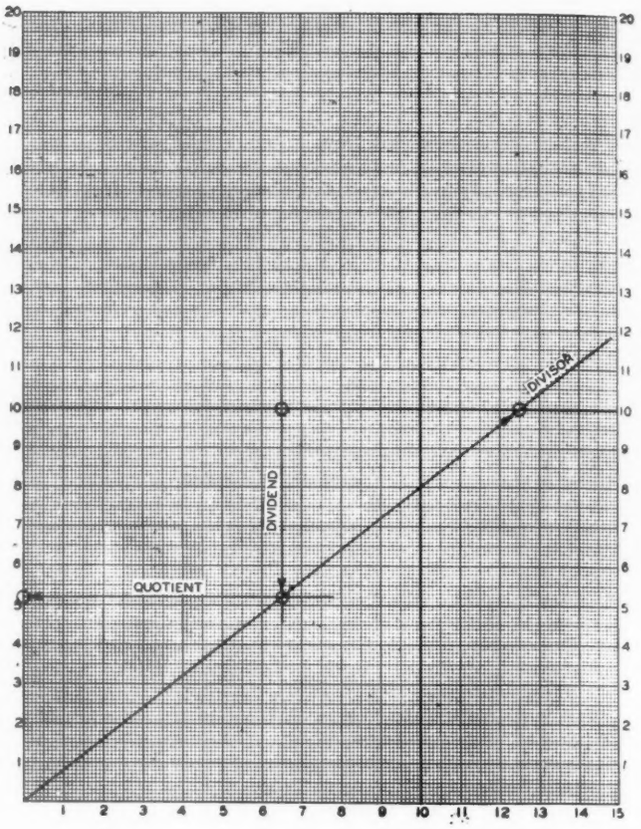
The first problem will deal with multiplication, the second with division, and the third with reciprocals. Although reciprocals are the results of division, I intend to show an extremely simple way of obtaining them. These problems and their solutions have been explained, with little difficulty, to our office workers. They use this method with speed and accuracy in their daily work.

On the device an arm is pivoted at the lower left hand corner. In the examples the center line on this arm is shown. ★★★

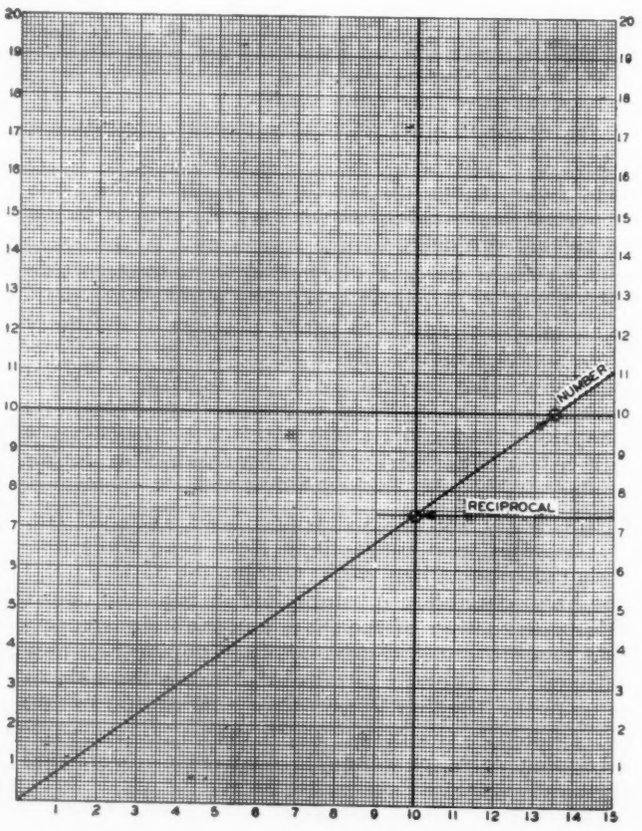
PROBLEM No. 1. MULTIPLICATION.
Given: The multiplicand and multiplier. *Required:* The product.
Procedure: Place C/L of arm on multiplicand on horizontal scale and where multiplier on vertical scale intersects C/L of arm, read the product on horizontal scale.



PROBLEM No. 2. DIVISION.
Given: The dividend and divisor. *Required:* The quotient.
Procedure: Place C/L of arm on divisor on horizontal scale and where dividend on horizontal scale intersects C/L arm, read quotient on vertical scale.



PROBLEM No. 3. RECIPROCAL.
Given: The number. *Required:* The reciprocal.
Procedure: Place C/L of arm on number on horizontal scale and read reciprocal of the number where C/L of arm intersects the right hand vertical scale.



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IMMEDIATE DELIVERY

ARC WELDERS...

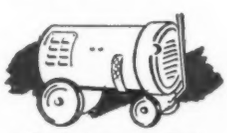
RELATED EQUIPMENT

New and used arc welders of well known makes, including Hobart, Lincoln and Westinghouse, in 200, 300 and 400 ampere ratings, either AC or DC, are now included in government-owned surplus and are available for immediate purchase and delivery.

Here you will find the equipment to modernize your shop—to replace worn-out or obsolete welders—to expand your business.

Lincoln—In all models and most ratings. Hundreds in the popular 300-400 Ampere size.

Hobart—Standard models of this make available in large quantities and most ratings.



Westinghouse — Portable models available in limited quantities.

Electrodes and Welding Rods — Millions of pounds available in all types and sizes.

EXPORTERS: Most surplus property is available to the export market. Merchandise in short supply is withheld from export, and if such items appear in this advertisement they will be so identified by an asterisk.

All arc welders are subject to priority regulations. VETERANS OF WORLD WAR II are invited to be certified at the War Assets Administration Certifying Office serving their area, and then to purchase the material offered herein.

Prices are low, based on the type and condition of the equipment. The inventory is located at various points throughout the country. It is broad and includes the machines you need. To obtain complete information on the availability, location and condition of the equipment you want **fill out the coupon and send it to your nearest War Assets Administration Regional Office.**

For full information clip and mail this coupon to:

War Assets Administration:
Please send me complete information on the availability, condition and location of the following types of equipment.

....Hobart Arc Welders	....Westinghouse Arc Welders
....Lincoln Arc Welders	....Electrodes and Welding Rods

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Transformer Type: Volts....Phase....Cycles....

Name.....

Firm.....

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City.....State.....

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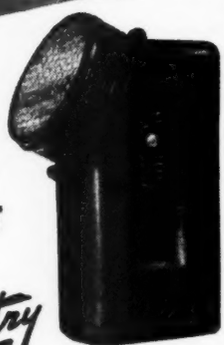
649-1

THAT'S WHY OIL MEN PREFER JUSTRITE



HANDY-SAFETY FLASHLIGHT RANKS FIRST IN *Oil Industry*

Model 17-S

Here is a flashlight that has proven itself made-to-order for use in the oil field. Its sturdy plastic case is guaranteed against breakage. It fits in palm of hand, stands on base, or attaches to belt with clip. It's approved for safety by Underwriters' Laboratories, Inc., and by U. S. Bureau of Mines.

Two Types of Light

Justrite Service Flashlite No. 17-S provides a fine spot beam of 1800 candlepower. For a larger spread beam, it can be used with the new Justrite Honeycomb Lens which throws a circle of clear even light 3 ft. in diameter at 8-ft. distance.

Ask your supplier about Justrite Safety Products.

JUSTRITE MANUFACTURING CO.

JUSTRITE
Safety Products
SAFETY CANS • OILY WASTE CANS
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Appoints Don Cummins

Don Cummins, youngest brother of C. L. Cummins, company founder and president, has been appointed quality manager of the Cummins Engine Company, Inc., to serve as final authority on decisions affecting the quality of Cummins engines.

Don Cummins

The new quality manager is well known in the diesel industry. He has been with the Cummins Engine Company since February, 1919, and played an important role in developing America's first successful high speed diesel — which Cummins introduced in 1932. Many of the new developments in high speed diesels also have come about as a result of his unbounded curiosity and patience. For the last five years, he has been director of research, in charge of the Cummins company's experimental and test laboratory, working closely with H. L. Knudsen, vice president in charge of engineering.

Mr. Cummins plans an integrated program to control the quality of Cummins engines to fully meet the specifications of the operators in the field. He will have full charge of all inspection departments, including inspection of purchased materials used in Cummins engines. He also will be in charge of an intensified program to interpret and teach the "user's point of view" to every member of the Cummins organization, from employes to top management.

To assure widespread use of the information he and his staff will gather in the field, Mr. Cummins also will institute an up-to-the-minute information service, channeling data to all of the more than 140 Cummins dealers and subdealers located strategically throughout the United States, Canada, and Mexico.

C.N.G.A. fall meeting

"Program arrangements for the 1946 California Natural Gasoline Association fall meeting have been completed," was the report given the association's executive committee at its August meeting by fall meeting chairman, Ed. Ragatz of Bechtel Bros. McCone Company.

Opening the morning session, Dr. B. H. Sage, California Institute of Technology, will present data and methods that natural gasoline plant designers and process engineers can use to predict accurately the thermodynamic properties of hydrocarbons. Then C. D. Gard and Hugh Colvin of the Union Oil Company will discuss the economics of LPG operations from the manufacturer's viewpoint. The final paper of the morning session will evaluate the various methods available for processing absorption plant rich oil.

In the afternoon, following President Kibre's address, Frank West of the engineering firm of West and Cole, will discuss the selection of absorption pressures for plants to be installed in high pressure fields. In the second paper, R. C. Alden of the Phillips Petroleum Company will discuss natural gas conversion by the Fischer-Tropsh process. The final paper of the meeting will be presented by Ragatz and will deal with the determination of absorber operating efficiencies.

The evening session will be in charge of CNGA entertainment chairman, Phil Mettling of Cooper-Bessemer Corporatoin. Mettling stated that his committee was rapidly completing arrangements for the dinner and show and that both would be of prewar quality.

The meeting will be held on Friday, October 11, at the Ambassador Hotel, Los Angeles. Additional information can be obtained by writing the California Natural Gasoline Association at 510 West Sixth Street, Los Angeles 14, California.

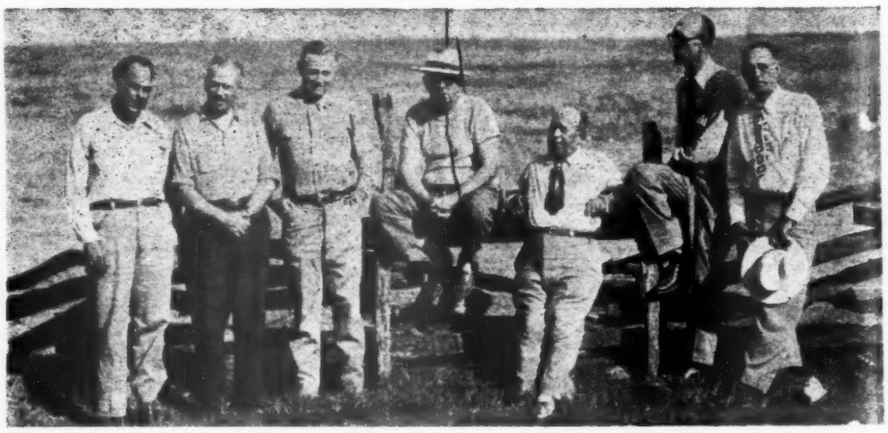
Pipeliners reunion

The D Bar Ranch, about 50 miles north of Fort Worth, Texas, played host to approximately 1000 persons during the Pipeliners' Reunion recently.

"Hobby" Dunn, owner of the ranch and president of the Eastern Construction Company, Inc., of Dallas, provided plenty of entertainment for all.

The honor guest of the occasion was Allen "Dad" Dunn, celebrating his 89th birthday. Dad Dunn is an old timer in the transportation business, having started out in the early days operating an ox wagon train during the time there was only five miles of railroad in the entire state of Texas.

Nearly every major oil and pipe line company was represented. Many arrived via plane, there being an excellent landing strip on the ranch.



Executives of various oil companies sitting on the "ole corral." Left to right: "Hobby" Dunn, president of Eastern Construction Company, Inc., and host to the pipeliners; Harry K. Phipps, Socony-Vacuum Oil Company, Wichita, Kansas; R. R. Irwin, president of White Eagle Division, Socony-Vacuum Oil Company; J. L. Latimer, president of Magnolia Petroleum Company, and Magnolia Pipe Line Company; Bert E. Hull, president of The Texas Pipe Line Company; A. N. Horne, vice president The Texas-Empire Pipe Line Company, and R. C. Sanders, Gulf Refining Company, Fort Worth, Texas.

Research center

Construction of a $3,000,000 research center by the Celanese Corporation of America is well underway at Corpus Christi, Texas, and initial operations will begin soon, officials of the company have announced.

J. E. Bludworth

An outgrowth of the Celanese Chemcel plant at Bishop, Texas, where chemicals are produced from natural gas, the center's prime research purpose will be for investigation and research connected with chemicals that can be derived from petroleum or petroleum derivities. It will work toward improvement of present operation and processes used at the Bishop plant and to development of new processes for output of the same products in more efficient, less expensive ways. It also will conduct research to utilize present products in other processes to make new or improved materials. In addition, it will train technicians and operators.

Joseph E. Bludworth of Corpus Christi is director of petroleum chemicals research and development division of the Celanese Corporation of America.

N.G.A.A. 1947 convention

The 26th annual convention of the Natural Gasoline Association of America will be held April 23, 24 and 25, 1947, in the Baker Hotel, Dallas, Texas, according to a recent announcement of William F. Lowe, NGAA secretary. Originally scheduled to be held in Tulsa immediately preceding the International Petroleum Exposition, the NGAA board of directors decided on a return to Dallas in 1947 after announcement was made of the postponement of the Exposition until 1948.

In stressing the need for early reservations, Lowe stated, "The growth in registration in recent years and the difficulty in obtaining hotel accommodations, have made it necessary to solicit the aid of all the leading hotels in meeting the requirements. Both the Baker and Adolphus hotels have already agreed to reserve large blocks of rooms and will accept reservations at any time, giving preference to requests for double occupancy."

Appointed chief engineer

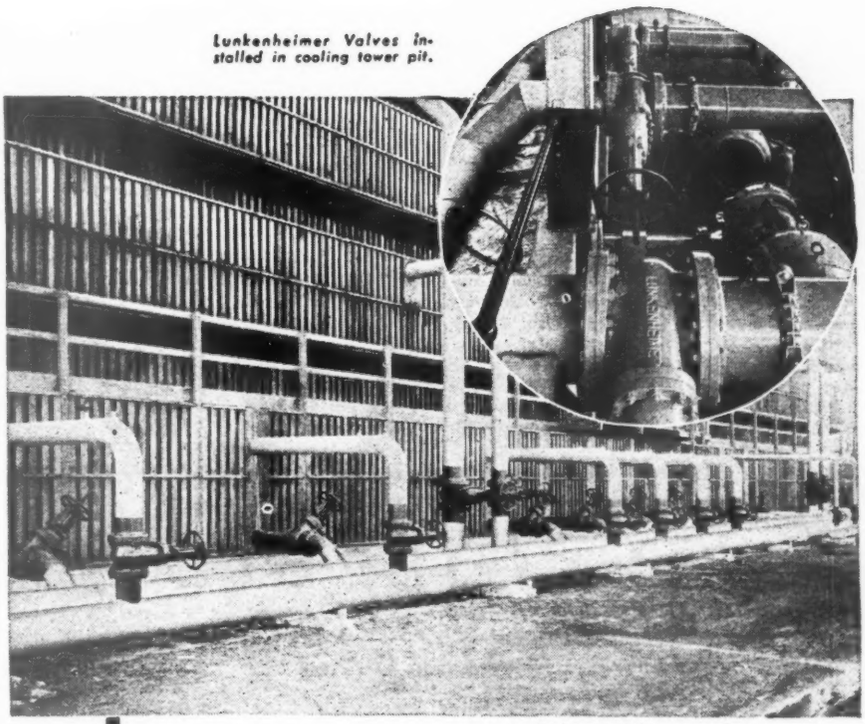
E. W. Chapman has been appointed chief engineer of the newly created Industrial Pump Division of Bowser, Inc., with headquarters in Fort Wayne, Indiana, according to an anouncement by J. B. Trotman, general manager of the division.

Chapman was formerly chief engineer of Blackmer Pump Company, Grand Rapids, Michigan, and has been active in the pump industry for the past 15 years.

Argentina representative

Hammond Iron Works of Warren, Pennsylvania, announce as their representatives in the Argentine the Tecnica Industrial y Comercial Petrolera, Soc. An. (known as TIPSA) whose headquarters are Av. R. S. Pena 501, Buenos Aires. The Hammond products that "TIPSA" will represent include globe roof pressure tanks, vapor-lift tanks, Hammond-Spheres, Spheroids, floating roofs, gas holders, and pressure vessels of steel, stainless, and stainless clad for the petro-chemical industries.

Lunkenheimer Valves installed in cooling tower pit.



Lunkenheimer Valves on cooling tower.

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Hanneken retires

After 44 years in the petroleum industry, George W. Hanneken, vice president in charge of manufacturing of The Standard Oil Company (Ohio), retired on September 1.

Marking his retirement, his associates honored him at a dinner at the Hotel Carter, August 29.

Born in Henry County, Missouri, where he attended public schools, Hanneken worked on the farm and in the wheat fields of the Middle West until he was 21. He then became a pipe fitter helper working on the expansion of the Neodesha Refinery of the Standard Oil Company in Kansas. He started working 10 hours a day at 16c an hour with no overtime.

When the construction job was finished he stayed at the refinery. In rapid sequence he became a pumper, a boiler fireman, a water station engineer, a stillman, night foreman in the refinery, and finally foreman of the cracking and coking stills.

In 1917, when The Standard Oil Company (Ohio) began making plans for the construction of a modern large-capacity refinery at Toledo, Hanneken came to Cleveland to assist in the planning. After two years, during which construction was held up by World War I, the refinery was started in 1919 and on its completion Hanneken stayed as superintendent.

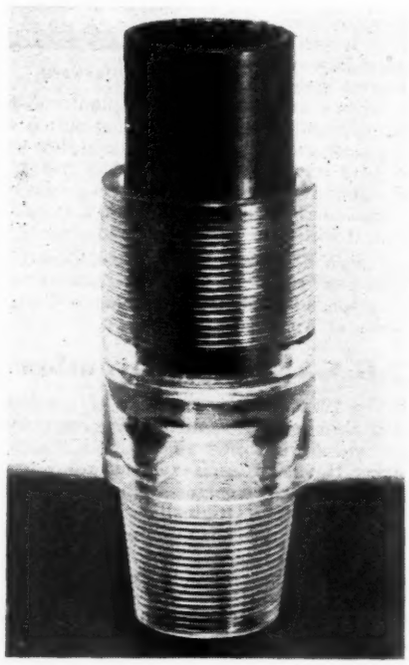
He remained in Toledo for 16 years and was brought to Cleveland in 1936 as general manager of the company's manufacturing department. He was made a vice president in 1939 and was elected a director in 1940.

Use plastic models

In order to show customers how its famous shrink-thread drill pipe actually works when replacing a wornout tool joint, The National Supply Company is providing its salesmen, field engineers, and store managers with plastic working models.

In replacing a worn-out tool joint in the field the same procedure is used as in the original factory assembly. It is expanded by heating, screwed onto the pipe, and allowed to cool. Upon cooling, the tool joint shrinks tightly on the pipe. The plastic models work the same way, the salesmen using hot water instead of a furnace to heat the tool joint.

The drill pipe end of the models is made of bakelite and the tool joint of transparent



lucite. Assembled, they are 3¾ in. long, exactly one-quarter the size of the original pipe and joint and, of course, very much lighter for the salesmen to carry. In reduced size they are exact duplicates of the original down to the finest detail. The salesmen can show how the special thread eliminates last-engaged thread failures and washouts by eliminating the notch effect at the bottom of the conventional "vee" type threads. It also can be seen how the conical seal, on the small end of the joint ahead of the pipe threads, prevents leakage and washouts.

A.P.I. nominating method

A new method of nomination for the American Petroleum Institute, authorized by its board of directors at the recent Dallas meeting, is announced by President William R. Boyd, Jr., with appointment of a committee on nomination.

Heretofore, a nominating committee has been appointed from the floor at the opening session of the board of directors at the annual meeting of the Institute. The new committee on nomination is charged to meet before the annual meeting, to which it will report, and agree on nominees for officers, members of the executive committee and members of the committee on membership.

Members of the Institute are permitted by the by-laws to make suggestions for nominations to the new committee.

Annual meeting of the Institute will be

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held this year at Chicago, November 11-15.

Members of the committee on nomination are: Robert E. Wilson, Standard Oil Company of Indiana, Chicago, chairman; Robert H. Colley, Atlantic Refining Company, Philadelphia; H. D. Collier, Standard Oil Company of California, San Francisco; J. C. Donnell, II, Ohio Oil Company, Findlay, Ohio; W. H. Ferguson, Continental Oil Company, Denver, Colorado; Walter S. Hallanan, Plymouth Oil Company, Pittsburgh, Pennsylvania; B. A. Hardey, Louisiana Mineral Board, Shreveport, Louisiana; George A. Hill, Jr., Houston Oil Company of Texas, Houston; B. Brewster Jennings, Socony-Vacuum Oil Company, New York; Reese H. Taylor, Union Oil Company, Los Angeles, and H. C. Weiss, Humble Oil and Refining Company, Houston.

Vice president Rector

Rector Well Equipment Company, Inc., Ft. Worth, announces the election of W. F. (Bill) Knode, internationally known consulting engineer in production problems, as vice president to serve in a research and advisory capacity.

W. F. Knode

Knode, a graduate in mining engineering at the University of West Virginia in 1921, has figured prominently in production problems since the late 1920's chiefly through work in the consulting engineering firm of Parker, Foran and Knode. He was chief engineer of the Oil and Gas Division of the Texas Railroad Commission from 1931 to 1934. He organized in 1938 the Alberta Conservation Board at Calgary, Alberta, Canada, and served as charman of that board for the first year. In 1941 he went into private consulting practice with offices in Corpus Christi, Texas, and shortly thereafter moved his headquarters to Ft. Worth.

A. J. Cunningham dies

A. J. "Casey" Cunningham, president of Standard Oil Company of Texas, Standard of California subsidiary, died August 20, in an El Paso, Texas, hospital, from the effects of a cerebral hemorrhage. He was 60 years old. The oil executive was stricken in El Paso, where he had gone on business from his headquarters in Houston.

Cunningham also was president and director of Pasotex Pipeline Company.

Opens uptown office

Opening of a new uptown district office in Wichita Falls, Texas, is announced by Oil Well Supply Company, Dallas, Texas.

The new office is at 702 Staley Building and is occupied by William Miskimins, North Texas and Panhandle district manager for the company, and Harris W. Quaite, district inventory control supervisor, and their staffs. Previously, the district office was at the Wichita Falls supply store of the company.

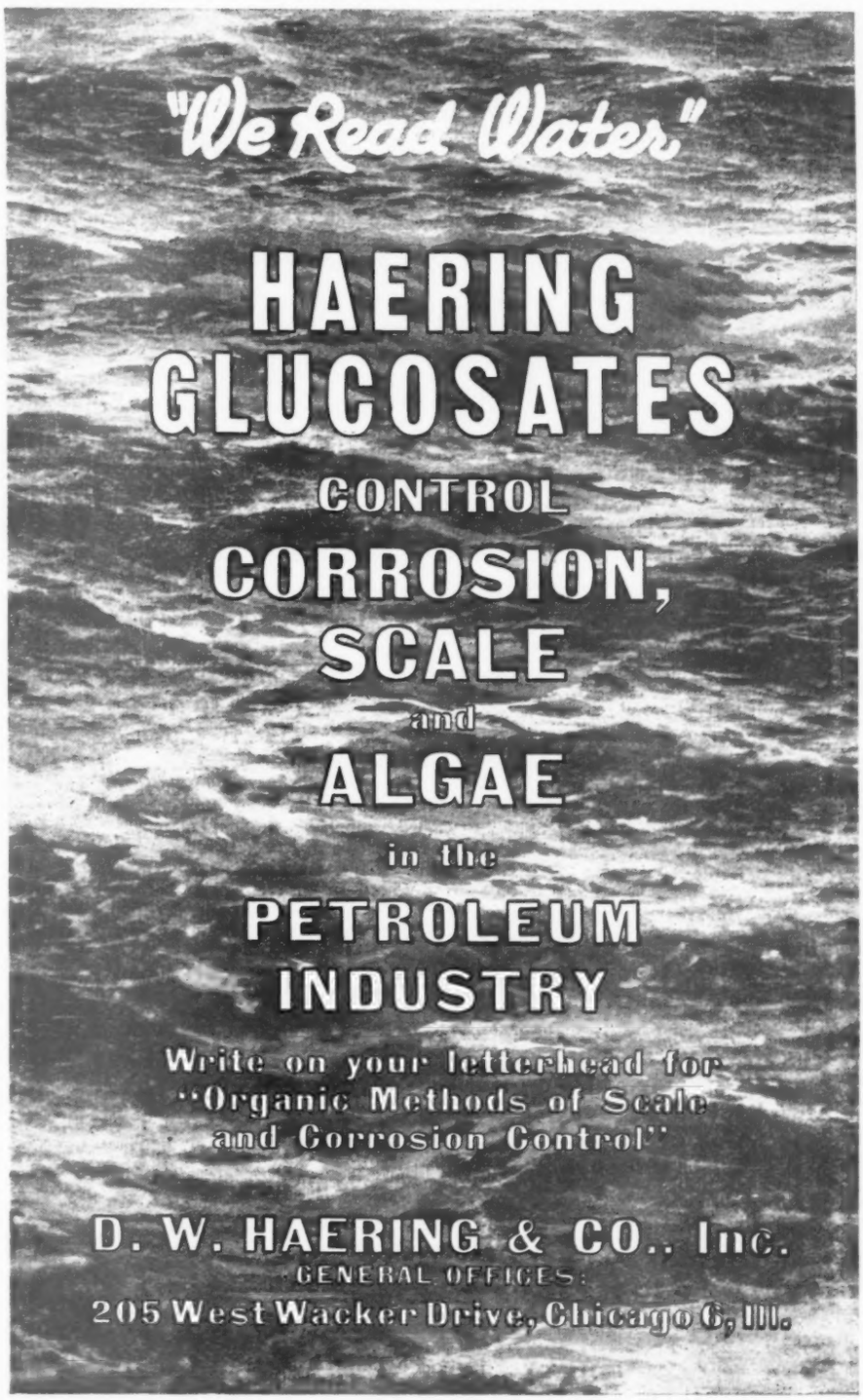
A.S.M.E. conference

After a lapse of several years, activity on the part of the American Society of Mechanical Engineers in the field of "petroleum mechanical engineering" is promised again through announcement by the Society that a three-day national conference on petroleum mechanical engineering will be held at the Mayo Hotel in Tulsa on October 7, 8, and 9. Technical sessions will offer nearly 50 papers by recognized authorities on subjects of vital interest to petroleum men concerned with production, transportation, refining, products application, and construction materials for petroleum equipment of all kinds. One important technical feature is a contemplated symposium on the design of vessels for high pressure, high temperature service.

Final programs and forms to facilitate pre-registration for the social features are available, either from the headquarters of the Society, at 29 West 39th St., New York 18, New York, or from the secretary of the ASME Petroleum Committee, E. W. Jacobson, Gulf Research and Development Company, P. O. Drawer 2038, Pittsburgh 30, Pennsylvania. The committee strongly urges those who are considering the possibility of attending to register with the secretary for inclusion on the mailing list; however, to insure hotel reservations, it will be desirable to write directly to the local committee as soon as possible, giving information regarding the number and type of accommodations required. Requests of this character can be addressed to the chairman of the Hotel Committee of the ASME Mid-Continent Section, D. A. Cant, 1312 East 15th Street, Tulsa 4, Oklahoma.

New meeting date

Houston Nomads are now meeting the second Monday in each month at Ye Old College Inn, 645 Main Street. Meetings begin at 6 p.m. Houston Nomads will continue meeting through the summer months and all visiting oil men and brother Nomads are invited to attend.



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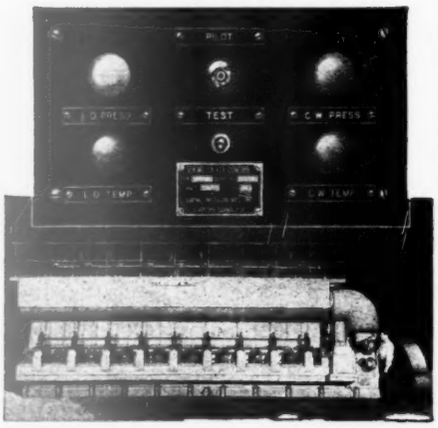

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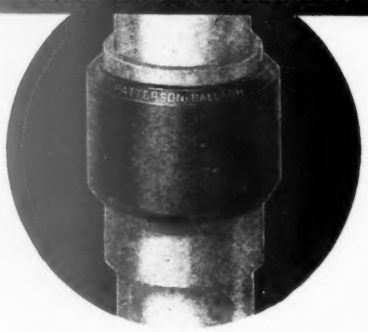

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Emsco chief engineer

Emsco Derrick and Equipment Company announces the promotion of Leroy Newcomb from assistant chief engineer to the position of chief engineer of the Los Angeles machinery department.

Leroy Newcomb

Newcomb, a graduate mechanical engineer of the California Institute of Technology, has broad background in engineering operations, having been closely associated with the petroleum industry for more than 15 years. Joining the Emsco Derrick and Equipment Company in 1936, his responsibilities for the last ten years have made him well known for his intimate knowledge of oilfield equipment design, engineering, and manufacturing.

In his new capacity, Newcomb will have jurisdiction over all engineering phases of Emsco's complete line of oilfield drilling equipment manufactured in Los Angeles.

G. F. Ilgen passes

Grover F. Ilgen, 58, vice president and general sales manager of Airetool Manufacturing Co., Springfield, Ohio, died August 27, in Columbus, Ohio.

Ilgen had been associated with the company since its inception in 1930 by his friend and business associate, W. T. Hamilton, Airetool's president.

Through his travels in North, South, and Central America as Airetool's representative Ilgen became one of the best known figures in the tube cleaning and tube rolling industry. For years he had served the major refineries of the United States and Mexico as a consultant on tube cleaning and tube rolling problems.

Ilgen is survived by his widow, Mrs. Hazel Ilgen, and one son, Grover William Ilgen, recently discharged from the Army Air Corps and now a student in Ohio State University.

Adds hydraulics division

A new hydraulics division, to specialize in the development of hydraulic equipment, has been established by the Rockwell Manufacturing Company, Pittsburgh. W. H. Marsh will be general manager of the division.

W. H. Marsh

Marsh attended Cornell University where he studied mechanical engineering. He joined the Pittsburgh Equitable meter Division of Rockwell Manufacturing Company in 1934 after previous experience with the Pittsburgh Coal Company, Gulf Refining Company, John F. Casey, and the Pennsylvania Pump Company.

South American trip

William H. Riggins, export sales representative for the Hydril Company, left from New York on September 15 for Trinidad, the first stop on a trip that will take him to Venezuela, Colombia, Peru, and Ecuador. He will visit Mexico on the return trip to Los Angeles, where he will arrive late in December. Before leaving on his trip, Riggins spent a week in New York with Earl M. Daniels, vice president and general sales manager of the company.

W. H. Riggins

Riggins has been with the Hydril Company for 8 years as field representative and sales engineer in Texas, the Mid Continent, and California. He has a thorough knowledge of the application and operation of Hydril equipment, and will stress field engineering during his trip.

Makes calls in plane

Pictured here is a new wrinkle in emergency field service inaugurated recently by Rector Well Equipment Company. The new Aeronca Champion, now based at Shreveport in charge of Tom Harrell, Rector representative in North Louisiana and Arkansas, is a fast means of getting on the job anywhere in his territory. Harrell has flown many hundreds of hours in other small aircraft covering his territory prior to the company's recent purchase of this 1946 two-place plane, which carries either an extra passenger or the equivalent weight in equipment. It lands and takes off in an unusually small area and is regularly calling at wildcat locations.

Harrell has a commercial license and an instructor's rating. Bob Smith, Rector representative in the Corpus Christi area, has recently completed flight training, and other Rector personnel are taking instructions as pilots.

"Pioneers" enjoy phenomenal growth

Mushrooming with all the spectacular zest of a boom town, the Petroleum Production Pioneers, one of the youngest organizations in the California petroleum industry, is rapidly becoming one of the largest. Just slightly more than two years old, it already boasts, according to J. E. Gosline, president, a total of 460 duly elected members, and a sizeable list of prospectives. It also has in progress, under the direction of Ted Sutter, historian, some very pretentious plans for the development, recording, and preservation of an authentic California petroleum history.

The formation of a production pioneers' association was first broached at an informal luncheon, late in 1943, at which were present Henry Grinnell, Lou Bronzan, and Glenn Merkley. The idea came out of a blue sky, but the more it was discussed, the more enthusiastic the trio became, and before they parted, they had scheduled another lunch to develop the matter further. There was no less excitement at this second meeting, and it was finally agreed that a larger representative group should be gathered together to test a more general reaction.

This meeting was held at the Los Angeles Athletic Club on January 26, 1944, with Henry Grinnell presiding, and some 40 oil field operators and equipment men in attendance. The basic idea as presented by the chairman was unanimously endorsed, and an organization committee was designated to draft a plan of action. One month later, the organization committee formulated its report. Briefly, it recommended two types of membership, Pioneers and Juniors, with tentative qualifications for each, and especially stipulated that the responsibility for meeting arrangements and all other chores rest solely with the Juniors. The plan was presented to a general meeting on March 30, 1944, was accepted and approved, and Petroleum Production Pioneers became a duly instituted and soundly established organization.

With Henry Grinnell as president, and Lin Little as honorary president—representing the Pioneers—the first two years of existence were largely devoted to simplification and clarification of association constitution and bylaws; the shaping of plans and policies, and a series of very interestings gatherings at which many petroleum pioneers found that congenial atmosphere and companionship that exists only where old time oil men convene. During this preliminary period of growth, the membership increased steadily from the original three to a robust 300, and included many men who had played significant roles in the foundation and early development of the California oil industry.

From January, 1946, to the present time, the organization has been under the presidency of J. E. Gosline, manager Southern District Producing Department of Standard of California, with F. F. Hill, former director of production for Union Oil Company, as honorary president. Approximately 150 new members have been added in the first six months of the year, despite the stringent qualification requirements, and all the aims of the organization have been advanced in a substantial way. This is especially true of the historical and biographical compilations, which are regarded as a major objective.

The executive committee of the Petroleum Production Pioneers. Left to right, standing, E. B. Fowks, T. A. Atkinson, J. J. Siegel, E. W. Webb, B. Bronzan; seated, S. H. Grinnell, F. F. Hill, J. E. Gosline, T. Sutter, R. Sneddon. Following members of the committee were unable to be present: Lin Little, L. G. Trembley, O. W. Morgan, Jr., C. S. Perkins, A. S. Hayes, W. R. Guiberson.

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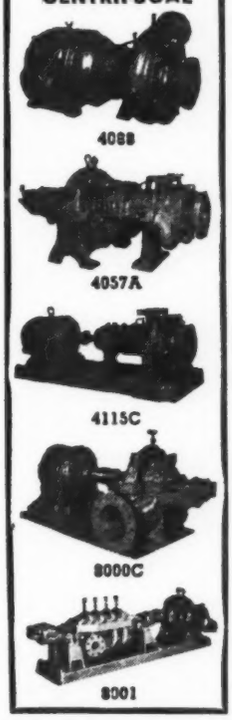

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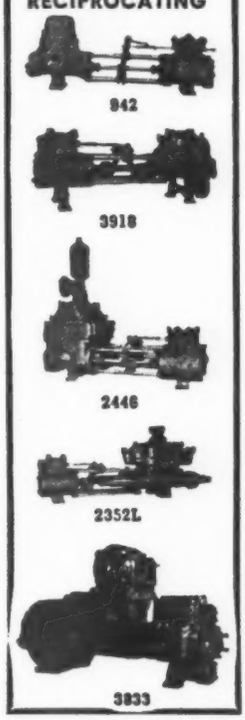

BRANCH OFFICES: NEW YORK HOUSTON

CNGA officers

At the annual meeting of the board of directors of the California Natural Gasoline Association announcement was made of officers, directors, and committees for the fiscal year 1946-47. After acceptance by incoming president M. W. Kibre of General Petroleum Corporation, of the gavel presented to him by retiring president M. L. Arnold, Richfield Oil Corporation, announcement was made of the election to the directorate of four new members: Coles B. Bason, Ingersoll-Rand Company; H. L. Eggleston, General Petroleum Corporation; C. L. Hutchings, Tide Water Associated Oil Company, and R. C. Patterson, Belridge Oil Company. George F. Howells, Tide Water Associated Oil Company and chairman of the Taft Chapter of the Association, is also a new director. George L. Tyler was reappointed secretary-treasurer.

M. W. Kibre

WANTED: CHEMICAL ENGINEER. New York engineering firm requires chemical engineer with minimum of ten years practical experience in process design and operation petroleum light ends units such as vapor recovery plants, stabilizers, ethelene recovery units ,etc., for senior supervisory position. Please state details of experience and salary expected. Address Box 50, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

HELP WANTED—Corrosion and Cathodic Protection Engineer. Graduate Engineer under 35 with some experience to supervise, direct and coordinate work of this character in connection with transmission of natural gas in Montana and the Dakotas. Address Box 52, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

ENGINEER WANTED—Major oil company desires several engineers, with bachelor of science degree and minimum of three years experience in petroleum production. Attractive future. State qualifications fully. Address Box 54, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

MICRO-PALEONTOLOGIST
CARACAS, VENEZUELA
Assists chief paleontologist in making stratigraphic correlation of well and surface samples by micro-paleontology. At least 3 to 4 years' experience. Degree. Write to:
THE ATLANTIC REFINING CO.
Rm. 900, Box 7258 Philadelphia 1, Pa.

HELP WANTED—Measurement and Gas Metering Engineer. Graduate Engineer under 35 with experience to supervise and direct measurement and testing in connection with production and distribution of natural gas in Montana and the Dakotas. Address Box 53, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

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REFINERY SUPERINTENDENT

We want a man of wide experience in topping, cracking, treating and all other phases of modern oil refinery operations, enabling him to take full charge of a large, complete refinery. Technical ability required and with it, exceptional initiative, executive ability and resourcefulness.

CHIEF ENGINEER

Must have wide and varied experience which qualifies him to take full charge of construction maintenance and process engineering of a large, complete oil refinery. Exceptional initiative, executive ability and resourcefulness required.

MARINE TERMINAL MANAGER

Thoroughly experienced in all phases of marine movements of petroleum products and the design, construction, operation and maintenance of a marine terminal.

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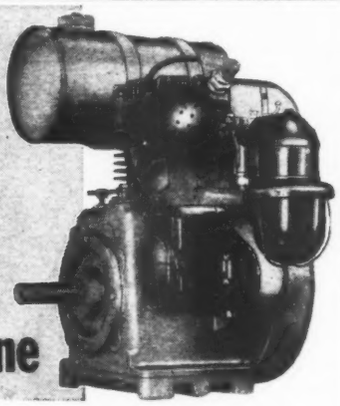

In designing power-operated equipment within a 2 to 4 hp. range . . . one of the vitally important considerations is to secure a power unit that can be depended upon for *heavy-duty serviceability.*

This is one of the predominant characteristics of the little Models AB and AK Wisconsin Air-Cooled Engines. Every detail of design and construction . . . from the Timken tapered roller bearing mounting of the crankshaft front and rear, to the mirror-honed cylinder . . . has been engineered for heavy-duty operation under rugged conditions. These engines are equipped with rotary type outside magneto impulse coupling, assuring quick, easy starting in any weather, at any season.

Write for detailed specifications and other pertinent data. Wisconsin Air-Cooled Engines are available in 4-cycle single cylinder and V-type 4-cylinder models in a complete power range.

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Mr. William M. Rose, Personnel Director
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75 Pitts Street, Boston, Mass.

Pioneers barbecue

Standard of Cal's Murphy-Whittier picnic ground was the scene of a gala affair recently when 350 Petroleum Production Pioneers and friends, from all parts of California, gathered together for their annual barbecue, and so thoroughly enjoyed it that they disported far into the night. As usual, the event was staged with what the society page calls the "Gay Nineties" motif. All officers, the executive committee, and many of the guests came arrayed in costumes that would have made Colonel Drake feel quite at home. That is, with the exception of Ox Morgan who came in a striped garb, depicting a fugitive from an 1890 chain gang.

Jim Gosline, president, was decked out in a lurid ensemble that would have shamed Diamond Jim Brady, and Frank Hill, honorary president, came as a fortyniner, concealed behind a false dundreary that has grown a full four inches since he last wore it. George Trembley, Ted Forsyth, Hudson Drake, and Lee Bushard, presided efficiently as usual, and in full regalia, behind the brass rail, and since it was a hot summer afternoon, were kept thoroughly occupied. Floating around, to provide competition for the gas engines that coughed in the background, were an accordionist and a barber shop quartet, but it was noticeable that the popular pastime was again the exchange of greeting and reminiscence for which these parties are primarily arranged.

There were, as there seem to be at all such meetings, constant shouts of surprise, as oldtime associates who hadn't seen each other for years, suddenly come face to face. Many stories were told of the rough and tumble days when the California petroleum industry was just beginning to take shape, and not a few of the pioneers brought old books, photographs, and records to substantiate their recitations. Represented among the pioneers was almost every petroleum and equipment concern on the prevailing California roster, and many that are no longer in existence.

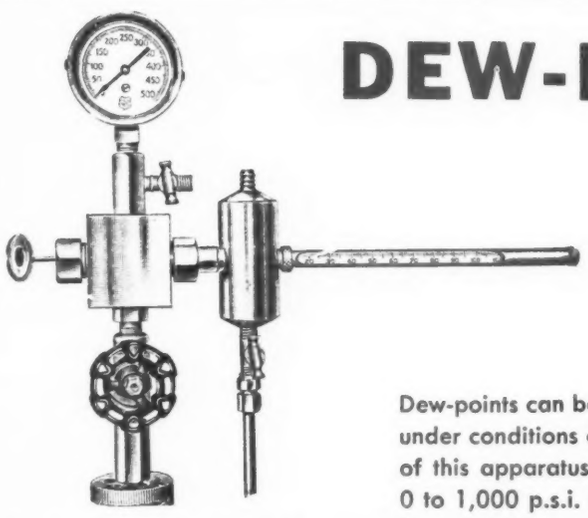
Noted in various groups scattered over the picnic ground were R. C. Stoner, Ernie Pyles, Tom Hickey, R. A. Broomfield, Fred Ripley—Sr. and Jr., Dick Guiberson, L. J. Bauer, Henri Wiethase—who got quite a bang out of our high school French, Lin Little—ex-prexy of the pioneers, Rodney Durkee, Norman Dorn, Clarence Hill, Warren Johnson, Frank Boyd, Tom Selser—he snaps your picture unknown to you, and then sends you match folders with your own gib right on the cover, Ford Alexander who was featured in *Life* a while ago as the pioneer of the oilmen's atomic bomb, Frank Skinner, Bill Clark—from Poso Creek, Ed Smith—needs no introduction, the Furman boys, the Garretson cousins, General Peeler, Hans Ross—whom we insist on mixing with Joe Swaton, Frank Brayton, Earle Moore, Jack Ballagh, John Grier, "Pat" Patterson—the man who is everywhere.

Continuing on, we find A. E. Fowks, whose 66 years in the oil business have had no apparent effect on his health, and hovering near are his two stalwart sons—Ernie and Al. Then there are Ben Youngken, Denny Driscoll flashing a keen sense of humor, Frank Dinger the jar expert, Gene Tiffany whose name sounds like jewelry, R. A. Sperry, Billy McLaine—a real artist in color photography, Web Wilson and his son Bill, Haskell Green, Earl Cater, Elmer Bolton, Les Black, J. R. Rector—no mistaking his relationship to Chris, Julius Dietzel, the Blodgets—Russ and Ward, Walt Greenfield—quartet organizer, Don Weaver and Gene Davis—top ranking production engineers, Ted Sutter, Dick Smith, Dad Wilcox, Jim Kibre, Bill Brooks—chairman of the Wildcats, Owen Haynes, Swede Larson, Bruce Hall, W. M. Brown, Zeb Dyer, J. McFaddin, Rudy Hartman—from Santa Maria, Sam Kelly and a gang from Bakersfield, J. A. Leuzinger—who thought we were smart to be able to spell his name, Hal Howard who lives in sand traps on golf courses, Garth Nicolson with a long string of good looking guests, Clarence Peck—the industry's most accurate decimal placer, Russ Green, Earl Daniels—newly elected vice president of Hydril, Julian Bennett, C. J. Coberly from whom Kobe takes its name, Joe Swaton, R. M. Cook, C. J. McLaren, and just dozens of others that time and space won't permit us to name.

There was a good delegation from the San Joaquin Valley, the coastal areas—especially Ventura, quite a few from San Francisco, and several out-of-staters. It was perhaps the biggest aggregation of historically important California petroleum pioneers ever gathered in one spot, and they enjoyed every minute of it, thanks to Lou Bronzan, Ernie Fowks and their aides who handled the arrangements for a record crowd in tiptop style, and to Joe Siegel and his membership committee who are really rounding up the consequential oldtimers in a remarkably effective manner.

J. F. Phelps, Jr., dies

John F. Phelps, Jr., organization counsel for Standard of California and widely known in petroleum marketing circles, died July 27 in Berkeley California, after an illness of several weeks.



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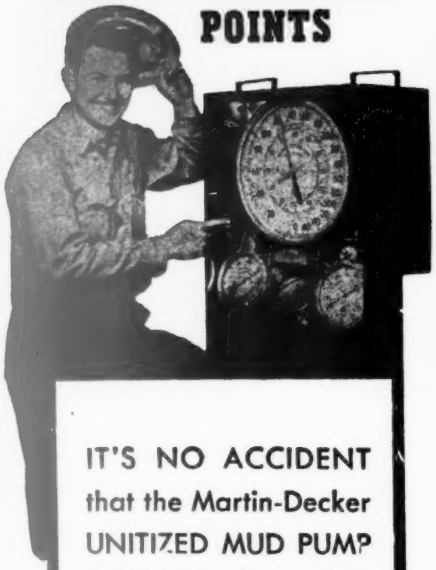

IT'S NO ACCIDENT that the Martin-Decker UNITIZED MUD PUMP GAUGE is the world's finest, most sensitive and rugged instrument for measuring slush pump pressure. The oil industry's leading weight recording measurement and control concern devoted years of development work to combining a special indicating gauge, a patented diaphragm unit, and a built-in pulsation damper in one unitized instrument requiring no tubings or fittings for connection. And best of all, it can be moved from location to location on a moment's notice.

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Floor construction

Surveys in various parts of the country indicate that at the present time fully one-half of the nation's industrial plants have floors in need of repair or rebuilding, as the result of hard wear during the war years when adequate maintenance was impossible and around-the-clock operation telescoped 15 years' normal wear into five. Nearly one and one-half billion feet of industrial flooring have been built in the last 20 years, so it follows that the total area of flooring in need of repair runs into sizeable figures. This is the timely background against which the Lone Star Cement Corporation has published an illustrated book on concrete floor construction.

This book outlines successful methods of building and repairing both normal duty and heavy duty floors, the latter including the entire range of floor construction where heavy trucking, hard wear, and more or less continuous exposure to water or other liquids are encountered. Years of extra wear can readily be obtained, the book points out, by avoiding five principal construction faults, sometimes existing in floor-building methods. These problems are discussed in detail and practical methods based on long experience are outlined for solving them.

After a brief but complete specification covering sound construction methods, the book takes up the problem now confronting plant executives in many factories where worn floors slow down trucking and increase operating costs, but where it is impossible by reason of the nature of the business to shut down the plant for the needed floor repairs. A method is outlined, which has proved successful over a period of nearly 20 years, whereby floors can be rebuilt over a week-end without tying up the plant for a single working day. In this connection, the text reads as follows:

"The final step in the construction of a concrete floor is curing. Neglect this one operation, and all the preceding care and exactness exercised in proportioning, placing, and finishing will not produce a satisfactory floor. This important fact is well recognized, and floor specifications, where ordinary portland cements are used in construction, demand six to eight days curing, and sometimes more, to assure dense, watertight and wear-resistant concrete. You can answer from your own experience how many jobs get that much curing. As a matter of fact, it is usually impossible to wait six or eight days—a floor has to be used, curing stops too soon, and quality of concrete inevitably suffers.

"In 1927, through a basic improvement in the process of manufacture, the Lone Star Cement Corporation introduced 'Incor,' America's first true portland cement with high early strength. Incor hardens faster—at 24 hours it has about 2½ times the strength of Lone Star Cement. In other words, Incor takes fullest advantage of the short time concrete can be kept wet under job conditions.

"Thus, in 24 to 48 hours, an Incor concrete floor is ready for heavy traffic—dense, durable, and watertight. Any floor can be kept wet one or two days—but a week or more is another story!"

Throughout the book, photographs and diagrams serve to summarize and highlight the text for easy reading. Copies of this timely book will be supplied upon request to the nearest office of the Lone Star Cement Corporation.

To International Nickel

E. A. Tice has joined the Corrosion Engineering Section of the Development and Research Division of The International Nickel Company, Inc., at New York, as a corrosion engineer. He was previously associated with Bethlehem Steel in the research department.

Informative series

The accompanying photograph shows the first five pieces of a series of 18 informative articles prepared by Core Laboratories, Inc., explaining core analysis and other services in the field of petroleum reservoir engineering, offered by the company. Reading clockwise the photograph shows Jones No. 5 explaining permeability; the core analysis price schedule; Core Lab's File Folder in which the series can be conveniently filed; Smith No. 8 discussing relative permeability, and a pictograph of Core Lab's operations. The center piece, the "Good Oil Report" showing a Core graph, is a facsimile of a core analysis report and fluid analysis report. New information will be developed each month until the series is complete.

New store managers

New managers have been appointed at three of The Continental Supply Company stores, according to a company announcement.

R. W. Griffin, formerly a salesman at Shreveport, La., has been transferred to the Artesia (Rangely), Colorado, store as manager.

The Russell, Kansas, store is now managed by Glen R. Pike, until which time he was a salesman with the company.

W. H. Darby is now manager of the store at Winnsboro, Texas.

Grant to university

Field research and training for the petroleum industry will be centered at the University of Texas for the coming year, through a $6000 grant received from the American Association of Oilwell Drilling Contractors.

For 14 years the University of Texas Industrial and Business Extension Training Bureau has worked with the petroleum industry of the state in the furtherance of industrial education and research in oil well drilling.

W. T. Payne, Oklahoma City drilling contractor, oil operator, and president of the contractors' organization, offered the grant for the association and it was accepted by the board of regents at its July meeting.

Plans for use of the money have been developed by Dean T. H. Shelby of the Division of Extension, James R. D. Eddy, director of the Industrial and Business Extension bureau, and John Woodruff, state coordinator of petroleum industry training.

These men will work with a committee on research and education of the drilling contractors' association, of which J. E. Warren of Midland is chairman. Other committee members are Howard Holmes, Dallas; Travis Kerr, Oklahoma City; I. W. Alcorn of Houston, and L. W. Sullivan of Tulsa.

In Texas the work will be developed with the cooperation of the trade and industries division of the State Board for Vocational Education. In other oil-producing states the work will be carried on in cooperation with state and local industrial education authorities.

Experimental work has been completed at Odessa, Kermit, and Wichita Falls. Plans for the coming year call for establishment of centers at Rangely, Colorado; Great Bend, Kansas; Oklahoma City and Tulsa, Oklahoma; Hobbs, New Mexico; Shreveport, Louisiana, and Kilgore, Beaumont, Houston, and Corpus Christi, Texas.

The first phase of the program will consist of field research and training in the use and control of drilling fluids. Drilling equipment and drilling practice are scheduled for attention as the work develops.

Handling Somastic coating

Taking over of all Somastic pipe coating operations in the 11 western states, and in all foreign countries, by Bechtel Brothers McCone Company of San Francisco and Los Angeles is announced by W. E. Waste, president.

As exclusive source for Somastic in this large area, BBM is prepared to provide coated pipe in all sizes, to coat pipe provided by others, or to undertake the laying of Somastic coated pipe lines, the announcement says. Somastic was previously handled by Industrial Engineering Company, which has now become merged with H. C. Price Company, exclusive agents for Somastic in 37 eastern states.

The New— BOWSER ESTABLISHED 1885

GAS TRAP ... for OIL WELLS

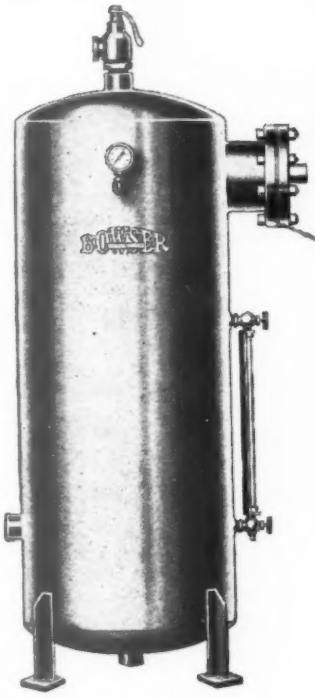
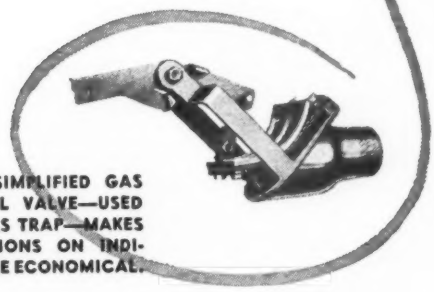


FIG. 426 GAS TRAP

WITH NEW.. SIMPLIFIED GAS AND OIL CONTROL VALVE...

- Eliminates Crude Spill-over into Gas Line
- No Packing Glands
- Operates on Vacuum or Pressure
- No Metal-to-Metal Seats
- No Grinding or Reseating
- Positive Action
- Nothing to Get Out of Order



THIS PATENTED, SIMPLIFIED GAS AND OIL CONTROL VALVE—USED IN THE FIG. 426 GAS TRAP—MAKES METER INSTALLATIONS ON INDIVIDUAL WELLS MORE ECONOMICAL.

The new Bowser Fig. 426 Gas Trap efficiently separates gas from oil in individual well installations or as a central unit for small lease operations.

It is an important part of the complete Bowser Automatic Well-Check System when combined with the Bowser Proportional Sampler and Special Oil Well Meter.

Write today for complete details on the new Bowser Gas Trap.

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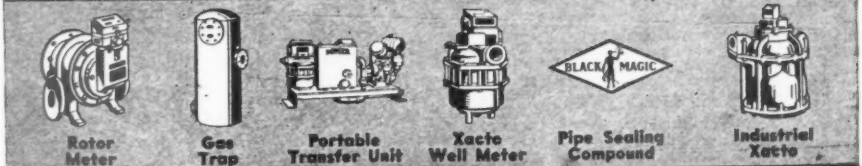

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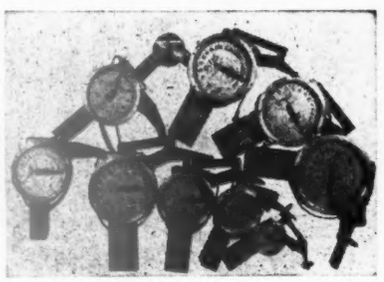

10 of the 20 Models we manufacture. 40,000 pounds to 500,000 pounds. A special scale for any job.

With a Line Scale you know the pull on the line, and the weight on the bit in pounds. Accurate, sensitive, rugged and economical.

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Gas short course

With an array of instructors reading like a Who's Who of the gas industry, Texas A.&I. College, Kingsville, Texas, conducted its first annual short course in gas technology August 27, 28, and 29.

More than 200 industrialists from 10 states attended the meeting, sponsored by the Southern Gas Association, to study dehydration of foods, natural gas transmission, and air conditioning.

P. C. Keith, president of Hydrocarbon Research, Inc., New York, warned the registrants that to withstand competition from the coal industry in the manufacture of gasoline they must constantly improve their processes and keep the price of the finished product down. He told how gasoline would be made from carbon monoxide and hydrogen at the $15,000,000 Carthage Hydrocol plant at Brownsville, designed by his concern.

In other general assembly programs, Dr. W. R. Hainsworth, vice president of Servel, Inc., New York, told of the advantages of using natural gas in air conditioning, Captain E. S. Pettyjohn, USNR, director of the Institute of Gas Technology, Chicago, described German synthetic gasoline plants, and H. M. Shedd, petroleum specialist for Carrier Corporation, Dallas, explained the operation and benefits of the centrifugal gas compressor. Dean A. Strickland of Houston, president of the Southern Gas Association, and Frank S. Kelly, Jr., Arkansas-Louisiana Gas Company, Shreveport, presided at the general assemblies.

Field trips were taken to installations in the vicinity, including a cycling plant of The Chicago Corporation and a gas dehydration plant of the Tennessee Gas and Transmission Company, both near Kingsville, and the Evergreen Farms cereal grass dehydration plant at Raymondville.

Entertainment included a visit to the King Ranch, where Dr. J. K. Northway, ranch veterinarian, exhibited Bold Venture, sire of Assault, Derby winner, and a barbecue, sponsored by the Kingsville Chamber of Commerce at the Humble camp.

Larry Ladewig of the Houston Natural Gas Corporation, Houston, arranged the program for the air conditioning section. It included Dale S. Cooper of Dale S. Cooper and Associates, Houston, "Introduction to Principles of Air Conditioning"; H. Charles Pierce, assistant manager, Air Conditioning Division, Servel, Inc., Evansville, "The Servel Method of Computation in Air Conditioning"; C. A. McKinney, United Gas Corporation, Houston, "Simplified Load Estimate Calculations for Residential Summer Air Conditioning"; George Elmer May, New Orleans Public Service, Inc., New Orleans, "Air Distribution Design."

Also, H. W. Heisterkamp, manager, Dehumidifier division, Bryant Heater Company, Cleveland, "The Design and Application of Gas-Fired Air Dryers in Air Conditioning Work"; J. K. Hawk, "Design, Research and Development of New Kathabar Residential Air Conditioner"; G. F. Zellhoefer, Eureka-Williams Corporation, Williams Division, Bloomington, Illinois, "The Principles of Operation of the Air-O-Matic Air Conditioner"; Dr. E. N. Berry, research director, Servel, Inc., Evansville, "Research and Development in the Servel Gas-Fired Air Conditioner."

Natural gas transmission was conducted by Elton Sterrett, National Association of Corrosion Engineers, Houston, and consisted of Jack Gordon, The Girdler Corporation, Louisville, "Dehydration of Natural Gas"; C. H. McRaven, Texas Pipe Line Company,

PUMPS for PETROLEUM PRODUCTS

Write for Bulletin 102— Pumps for the Petroleum Industry

It will tell you why
BLACKMER ROTARIES
are SELF-ADJUSTING FOR WEAR

GATHERING PUMPS
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Capacities to 750 GPM.
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SERVING THE PETROLEUM INDUSTRY FOR 40 YEARS

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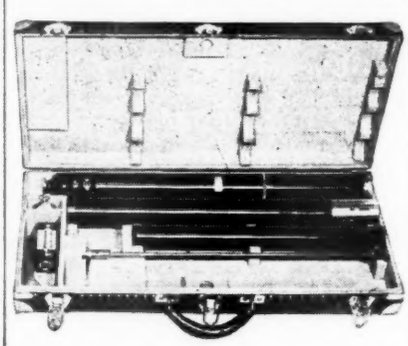
presents...
POST WAR MODEL
***Multiple Shot* OIL WELL SURVEY INSTRUMENT**



Makes a continuous record in one run of the direction ot the hole and its deviation from the vertical. The complete survey is plotted in our offices and a finished copy supplied to the customer. For accurate, dependable surveys, call the *Pioneers* of oil well survey service.

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Houston, "Cathodic Protection"; T. B. McDonald, Texas Pipe Line Company, Shreveport, "Sacrificial Anodes"; M. E. Parker, Jr., Pan American Pipe Line Company, Houston, "Soil Surveys"; Homer Givens, La Gloria Corporation, Falfurrias, "Instrumentation-Lecture With Laboratory Demonstrations," a demonstration by J. A. Rossiter of J. A. Rossiter and Company, Houston, and Pratt Daniel Company, of his Airotec air gas cleaner, and a joint meeting with the section on dehydration, presided over by R. M. Hutchison, research director, Houston Natural Gas Corporation, Houston.

Dr. W. G. Hugly, Southwestern Settlement and Development Corporation, Houston, organized the program for the section on dehydration. On it were Hutchison, reading a paper, "Uses for Old and New Crops," prepared by Gilbert C. Wilson of Gilbert C. Wilson Laboratories, Pittsburg, Texas, who could not attend; E. C. Whipple, Santa Fe Railroad, "Dehydration of Farm Products and the Natural Gas Industry"; George C. Lockhart, Arnold Dryer Company, Corpus Christi, "Dehydration of Hay Using Natural Gas"; Dr. Hugly, "Feeds and Foods for Dehydration"; J. W. Sorenson, Jr., Texas A. & M. College, College Station, "Fuels Used for Individual Farm Hay and Grain Dryers"; M. R. Van Valkenburg, consulting engineer, Houston, "The Economics and Construction of Rice and Grain Dryers."

Also, F. C. Brandt, Minneapolis-Honeywell Regulator Company, Houston, "Heat Control for Dehydration"; W. A. Harding, Evergreen Farms, Raymondville, "Experiences in the Dehydration of Cereal Grasses and Other Farm Products"; and W. J. Edminster, Valley Vitamin, Inc., McAllen, "By-Products From Alfalfa."

Demonstrations included gas analysis procedures using the Turner Burrell solid adsorption fractionater and superfractionation equipment and electrolytic model studies of sub-surface gas flow by Emerson Korges, A. & I. engineering professor, and Durward Emery, A. & I. research fellow.

Dr. Frank H. Dotterweich, head of the A. & I. engineering department, was chairman of the administrative committee, consisting of Robert R. Suttle, managing director of the Southern Gas Association, Hugly, Sterrett, and Ladewig.

J. S. Fluor, Jr., resigns

P. E. Fluor, chairman of the board of The Fluor Corporation, Ltd., Los Angeles, California, has issued the following announcement:

"It is with deep regret that the board of directors of The Fluor Corporation, Ltd., find it necessary to announce that our executive vice president and general manager, J. S. Fluor, Jr., tendered his resignaiton effective September 1, 1946. We considered him one of our most valued men. He now will devote his entire time to his many outside interests."

New Continental stores

Two new stores have recently been added to The Continental Supply Company group.

One of the new locations is Lindsay, Oklahoma, with M. M. Morstrand as store manager and operating under the supervision of W. O. Timberlake, assistant district manager at Oklahoma City.

C. A. Wade has been named manager of the new store at Eunice, Louisiana. This store will be under the supervision of the assistant district manager at New Iberia, Louisiana, A. P. Lacey.

Oilmen may argue about the relative merits of drilling equipment, refining and transportation, but many of them agree that Pyrene Foam is proper protection for oil and gasoline fires. Tests have shown Pyrene's speed and positive action in blanketing blazing oil in a layer of fire-killing foam. Pyrene engineers have designed equipment for every size risk — from hand extinguishers for small trucks, motors and electric equipment to extensive piped installations for tank farms and refineries.

Findlay, Ohio, tank test. A 93-foot tank of flaming oil was extinguished in 4 minutes with the same foam as produced by the Pyrene Foam Playpipe.

Pyrene Foam Playpipes meet fire protection requirements for flexibility, fast action, ease of operation and dependability. They may be used anywhere ordinary or salt water supply is available. By coupling a Pyrene Playpipe to the nozzle of a water hose, hundreds or thousands of gallons of fire-blanketing foam can be produced. One gallon of Pyrene Foam Compound and 19 gallons of water make 350 gallons of foam per minute.

Pyrene gives you equipment for every hazard. Check your present protection now; let a Pyrene engineer help you prevent serious fire loss from inadequate equipment. Write for AIR FOAM, a booklet on flammable liquid fires.

Pyrene

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ZINC
for
LONG-TIME, LOW-COST
PROTECTION
AGAINST
RUST

The U.S. Bureau of Standards, Circular #80, says, ". . . by far the best" protective metallic coating for rust-proofing iron or steel is ZINC. Zinc, in the form of galvanizing, protects against rust in TWO WAYS: First, by simple coverage, with a sheath of rust-resistant metal . . . Second, by electro-chemical action, or "sacrificial corrosion." That's why industry has long depended on ZINC to stop rust—cut costs—save materials. Heavy coatings pay—for the heavier the coating, the better the protection, the longer the service life and the lower the cost.

ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

The "Seal of Quality", shown above, is the yardstick of economy in buying galvanized sheets. It signifies at least 2 oz. of Zinc per square foot!

FREE BOOKLETS

WRITE TODAY for these valuable booklets; (1) Repair Manual on Galvanized Roofing & Siding (2) Facts about Galvanized Sheets (3) Use Metallic Zinc Paint to Protect Metal Surfaces.

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Pacific Personalities

DICK SNEDDON

Ever since we were knee high to a fishtail bit, we have consistently upheld the dignity of labor. Nothing is more encouraging to a worker than to have the conviction that what he is doing is not only necessary but important. At a large Western refinery many years ago, we became acquainted with a nice, rather elderly gentleman, whose duty it was to kill the gophers that were undermining various structures and foundations, and simply ruining the beautiful garden that surrounded the refinery office. He carried, strapped to his back, a cylinder of sulphur dioxide, and every time he ran across a gopher hole, he released the hose, and squirted some SO_2 into it. Then he took out his notebook, and put a "one" in the column marked "Gophers Killed." So far as we knew, he never recovered any of the bodies, but there was no question in his mind that each spurt accounted for one gopher, and every year, he used to make out an elaborate report, showing the number of gophers killed per day, per month, and per annum; the quantity of sulphur dioxide required for each individual disposal; and the grand cost of the extermination, taking into account his wages, the quantity of gas used, and the depreciation on his equipment. This old chap really believed in himself and his occupation, and he thoroughly enjoyed it. If he were alive today, he would have to bring in gopher hides to prove his statistics. That's the heck of science!

●

All of this reminds us that when we first met Jack Ballagh, which wasn't yesterday either, he was keeping, and indeed had kept over the years, an amazing record of the cost of maintaining and operating a'l his automobiles, from the first one he ever owned to his latest acquisition. There was nothing missing from his accounting. It was a detailed accumulation of statistics and information, from which he could quickly determine the life expectancy of any piece of equipment on the several machines he had owned, and could tell offhand the ultimate or per mile cost of fuel, lubricant, tires, batteries, or any other automotive accessory in which one might be interested. We were even led to understand that he could give you the mileage per fender dent, but that is probably a mild exaggeration. Incidentally, in these days Jack did a great deal of driving, and to forestall any tendency toward "stenographer spread," on long trips, he never drove for more than 55 minutes at a stretch. Then he got out of the car and swung a golf club for five minutes. Watching his recent performance on the golf course, there is no acute evidence of all this practice, but neither is there any evidence of "stenographer spread."

●

Visiting at the fine Santa Monica Canyon home of Jock Chapman, art connoisseur, who is not an oil man but seems to like them, for he always has plenty of them around, we bumped into our old friend Bryce Gillespie, the General Petroleum Corp exec, just back from a vacation in the Canadian northwest, and looking mighty chipper. It used to be a real thrill for a Scot to vacate up in the Dominion, because when he planked down a ten dol'ar bill for a package of cigarettes he got his fags and about eleven dollars change. Now, however, the two currencies are on an even-Steven basis, and we Caledonians don't seem to have such a riotous time. Bryce reports that in spite of this distressing situation he had a grand time. And he tells us that the Canucks really like the "yanks" so well they have begun to call them "Southern Canadians."

Also holding forth at this party to a group of patrons of the extremely liberal arts was John Grant, reciting copiously and eloquently from the works of Robert Burns, and Billy McGraw, two of Scotland's most revered poets, and occasionally, we suspect, quoting from some of his own compositions. We heard him particularly and earnestly exhorting one young man to "never let your carnal desires overcome ye—for it's nayther guid for the constitution nor the poaket!" A moment later he was congratulating a good looking lady on recently having become a grandma, and handing her a pretty penny "Tae buy something for the wee yin." All of which shows that a good oil man is at home in any company.

●

Now comes word that these famous dude ranchers, Phil Rockfellow, Union's personnel manager, and Jack Pate, southern district pipe line manager, have acquired a couple of mules with exceptionally long ears, and exceptionally obstinate dispositions. It is not known whether this is an attempt to tide the boys over a possible meat shortage, or whether they will actually break the animals to saddle, and use them to help solve the parking problem. In any case, we understand that a book is being made up on the deal, and the wise money says it is an odds on shot, that if these embryo cowboys get

within shooting range of the mules' transmission, there is likely to be a new record established for sustained flight by humans, gliding without the aid of wings.

●

The ubiquitous Bill Pemberton, who has now become a radio performer under the wing of Don Gilman, tells an interesting yarn about an oil man who played the ponies pretty regularly on hunches. On June seventh, he was looking over the entries at seven o'clock in the morning, when he noticed that the seventh horse in the seventh race was named "Seven Up." To top it all, the entries were listed on page 7 of his newspaper, and in his pocket he had exactly seventy-seven dollars. For a hunch player, the setup was perfect, so he called up his bookie and laid the entire seventy-seven simoleons on the nice soft nose of "Seven Up." The hunch worked, too, when the results came out, you can imagine his surprise to find that "Seven Up" had run—seventn! And, by way of concluding this Pemberton saga, one lad who had heard Bill make many speeches at oil men's gatherings and then heard him over the air, said he sounded "good but restricted."

●

We note in a recent billet doux from Joe Siegel that Lew Hilton is now a member of the Petroleum Production Pioneers, which ought to bring some interesting material into Ted Sutter's historical file. Lew is loaded with yarns and information about oil people and their activities in the early days of the California petroleum industry, and we hope he may be given an opportunity to unload one of these fine days under the proper circumstances. For the moment, congratulations are in order, and we shall look forward to seeing Lew at one of the Pioneer parties—perhaps the Christmas one. Here's hoping.

●

Just had a letter from Mrs. Lynton in Paris, telling us that Ted, of the Institut du Petrole, is now browsing around Houston, and from other sources we learn that part at least of his mission is to hire drillers for the French Government. It is our earnest hope that Ted will jump to California long enough to let us freshen up on our high school French. Among the Spanish speaking oil and equipment people out here on the Coast, our linguistic talent lies mumbling under a thick cloak of suspicion. We can't speak a word of Spanish and in consequence are despised and rejected at Nomad meetings and other places, where the Spanish lingo is thrown around with a fine abandon, and a broad Los Angeles accent. Some time, with a straight man like Ted Lynton to complete the act, we intend to parlez vous these Spaniards into submission.

●

Harold Clark is deserving of special mention for the grand job he is doing with the AIMME News Letter, which is definitely all of that. It improves with every issue, and that is saying plenty, for it has been a real News Letter right from the start. From its "Here and There" column we learn that Bill Porter II is expecting—to become a landlord in the spring. At the present time, he is working hard on a juvenile "Big Inch" that will carry water, he hopes, from a nearby spring to his homesite on the desert. Carl Tutschulte of the Tide Water Associated is back after a nice tour of the East, where he investigated all manner of secondary recovery systems. This is the equivalent of the postman going for a walk on his day off, and shows how much an oil man's work actually becomes his life after a while.

●

Don Nutter, production engineer with Shell, has been transferred from Long Beach to Bakersfield, which is a nice move if you like Bakersfield—and lots of people prefer it to the south. Personally, some of the best hours of our long and hectic existence have been spent in the Valley. When we were a mere child in the oil game we traveled over the old pipe line road from the Four Corners to Coalinga, bouncing out of one ditch into another, but feeling very much like a man in spite of appearances. And how we used to listen to the old timers talking about the fellows who were old timers to them. And it is terribly hard to believe that some day we'll be old timers too.

●

By way of conclusion, we note with pleasure that Roy Collum is back on his feet again, after resting up from a major operation, and wish him a full and speedy return to his normal good health. All of which recalls the pumper who was having stomach trouble so he went to see a doctor, and was told after a thorough examination that he must go on a diet, a very restricted one. When he got the doctor's bill, he had to.

Burtner general manager Midco

Randolph C. Walker, president and general manager of the Aireon Manufacturing Corporation, has announced the appointment of Herbert E. Burtner to the post of general manager of Midco Tool and Supply Company of Oklahoma City, Oklahoma.

Burtner, who was born and raised in the Kansas City area, has devoted the larger portion of his life to the oil field supply business in the Southwest. Previous affiliations include the Gustin-Bacon Manufacturing Company, Owens-Corning Fiberglas, Mid-Central Supply Company, and Reilly-Benton Company, Inc., and lately Burtner was special representative in Fort Worth for Rodman Supply Company.

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Book Reviews

• **When the Oil Wells Run Dry,** *by Walter M. Fuchs. Published by Industrial Research Service, Masonic Building, Dover, New Hampshire. Price, $3.75. Pages, 447.*

This is the story of oil—its past, its present, and its future, told in words that everyone can understand by a man who not only knows the oil problems of America but was closely connected with the synthetic oil developments in Germany. Dr. Fuchs tells how motor fuel can be made from coal and gas, and how much it will cost, how the uranium atom can be disintegrated to blast a city off the map, and whether its energy can be controlled to raise our standard of living to undreamed of heights. He explains how oil can be converted into rubber, into alcohol, and into many other products that formerly were obtained only from plant and animal life.

This guide book presents in one convenient volume an integrated picture of the subject of oil. It is a balanced presentation of important social, political, and scientific oil facts that can serve a broad audience as a handy reference book.

• **Steam Trapping and Air Venting,** *by L. G. Northcroft. Published by Chemical Publishing Company, Inc., Brooklyn, New York. Price, $4.50. Pages, 172.*

This volume is a complete work of reference on steam trapping and air venting methods. It explains that old knowledge and incorrect applications of steam traps should be forgotten before a steam-using plant can be run economically. Stress is laid on the importance of correct and up-to-date methods of condensate drainage. From the standpoint of steam economy and output efficiency, adequate air venting arrangements for heating and process purposes are regarded as equally important. Such methods are discussed in detail.

• **The Petroleum Industry,** *by Josephine Perry. Published by Longmans, Green and Company, 55 Fifth Avenue, New York. Price, $2.00. Pages, 128.*

This history of the petroleum industry describes briefly the early struggles of the crude-oil business, which had its beginning in Pennsylvania in 1859, and goes on to picture the tremendous advancements that have been made in obtaining, processing, and transporting petroleum. Also of special interest are the chapters on marketing and research. This volume contains much interesting material on by-products of petroleum, on the early history of its uses, and on the probable future developments within the petroleum industry.

• **The Future of Industrial Research,** *published by Standard Oil Development Company, 30 Rockefeller Plaza, New York 20, N. Y., 173 pages.*

In commemoration of its silver anniversary of existence, Standard Oil Development Company has prepared this forum discussion consisting of papers from leading experts in manufacturing and petroleum industries. The discussion, led by such names as C. F. Kettering, General Motors, Morehead Patterson, American Machine and Foundry, and Lammot du Pont, E. I. du Pont de Nemours and Company, Inc., limits its theme to three subjects: (1) "What should be the guiding principles and objectives for the commercial programs of industrial research and development organizations?" (2) "How can small business serve itself and be served by industrial research and development?" (3) "What place should industrial research and development organizations allocate to future work directed primarily toward national security?"

• **The Wildcatters,** *by Samuel W. Tait, Jr. Published by Princeton University Press, Princeton, New Jersey, Pages, 218. Price, $3.00.*

A collection of thrilling firsts in oil seeking is Samuel W. Tait's "The Wildcatters." A diverse and highly individual group of men were the great figures of wildcatting. From Drake to Gutowsky they march across the pages, some dogged by bad luck, others blessed with an oil-Midas touch. The author speaks confidently, much of his material he gained at first hand and for the remainder he depended on first-rate authorities. A book for the oil man's history section that he will enjoy and use.

● **Stratigraphy of the Golden-Morrison Area, Jefferson County, Colorado.** *Quarterly of the Colorado School of Mines. By L. W. LeRoy, assistant professor of geology, Colorado School of Mines. Price, $2.00. Pages, 116.*

This paper constitutes a report on an intensive investigation conducted by the author and represents a distinctive contribution toward geology, not only to the complex area discussed, but also of Colorado. Complete in its discussion of the stratigraphy of the area from pre-Cambrian to Tertiary, the report includes 23 figures, 11 plates, numerous detailed sections and a bibliography.

● **Uranium and Atomic Power.** *By Jack DeMent and H. C. Dake. Published by The Chemical Publishing Company, Inc., Brooklyn, New York. Pages, 335. Price, $4.00.*

Here is a volume containing all the information essential to a thorough understanding of atomic power and the atomic bomb. The chapters of this clearly-written practical book cover the occurrence and properties of uranium minerals, chemistry and physics of uranium, and specific methods in uranometry. A new section on the atomic bomb and numerous tables giving data concerning natural stable isotopes, isotopic masses, neutrons, and nuclear reactions round out the subject matter on the heaviest natural element, uranium.

The authors are Jack DeMent and H. C. Dake, editors of *The Mineralogist* and authors of Fluorescent Light and Its Application.

● **Encyclopedia of Hydrocarbon Compounds. Volume I—C_1 to C_5.** *Compiled by Dr. Joseph E. Faraday. Published by Chemical Publishing Company, Inc., Brooklyn, New York. Price, $15.00.*

Faraday's Encyclopedia will greatly simplify and expedite the literary research in the case of hydrocarbon compounds. The first volume of the Encyclopedia deals with hydrocarbons containing one to five carbon atoms. It is presented in loose-leaf form, which will help to keep it up-to-date. Every year an annual issue of new sheets will be offered to the buyers of the book. These are to be inserted in the proper order for completing the volume with the latest developments. Other volumes of the Encyclopedia will follow at short intervals, and, with the aid of the loose-leaf system and the easy-to-handle binder, additional useful information will be added with minimum effort.

● **Techniques of Glass Manipulation in Scientific Research,** *by Julius D. Heldman. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York, New York. Price, $3.60. Pages, 132.*

This book is designed for the technician, the chemist, the biologist, the physicist, and all others who at some time find it desirable to repair breaks in glass apparatus. It has been the author's observation that the greatest hindrance to the successful teaching of a technical subject is language block—the use of terms familiar to the teacher or writer but foreign to the student or reader. For this reason, a glossary of terms has been included, so that the proper technical terms used in the book may be at once referred to and understood. The book includes many helpful tables, diagrams and pictures.

● **The British Engineers' Association—Classified Handbook of Members and Their Manufactures — 1945 Edition.** *Published by the British Engineers' Association, 32 Victoria Street, Westminster, London, S.W. 1, England. Pages, 604.*

This is the sixteenth annual edition of the B.E.A.'s classified handbook of members and their manufacturers. It contains an alphabetical list of members, member page announcements and a classified list of manufacturers.

● **Optical Instruments,** *by Earle B. Brown. The Chemical Publishing Company, Inc., Brooklyn 2, New York. Pages, 567. Price, $10.*

Written to fulfill the need for a volume covering the field of optical instruments, this book discloses the basic principles of design and function as well as adjustment of the various common types of instruments.

Emphasis has been placed on the telescope because the majority of optical instruments are telescopic in principle. An extensive chapter on the spectroscope and on the range finder is included. Material on the care and maintenance of optical instruments is also carried in the volume.

● **The Industrial Republic,** *by P. W. Litchfield, chairman of the board of the Goodyear Tire and Rubber Company. Illustrated by Fred Ludekens. Published by The Corday and Gross Company, Cleveland, Ohio. Price, $4.00. Pages, 224.*

Supplementally titled "Reflections of an Industrial Lieutenant," Litchfield's book presents the views he has gained through a half century of industrial experience. This volume is in four books, 1. The Industrial Republic (1919). 2. Industry Under Industrial Assembly (1919-36). 3. Industry Under National Unions (1936-46). 4. A Democratic Solution. The first book is a reprint of a book on the same subject which Litchfield wrote in 1919. The principles this book expounded found expression in an employee representation plan that operated for almost two succeeding decades under the name of The Goodyear Industrial Assembly. In the second section, Litchfield reviews the record of the Assembly, analyzing its strength and its weaknesses in the light of experience. The impact of modern unionism on the Goodyear company is covered in the third section, discussing the methods and results of the violent period that began with the Goodyear strike in 1936. In the fourth and concluding section, the Litchfield book discusses wages, profits, taxes, government controls, and the methods of communistic and fascistic dictatorships and offers the outline of a plan for American production—industrial democracy.

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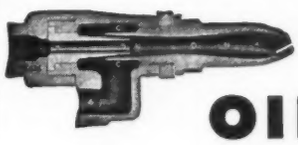

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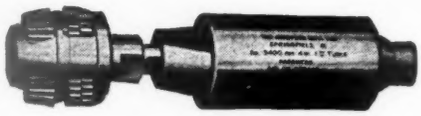

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Heads Carthage Hydrocol

The election of Guy George Gabrielson as president of Carthage Hydrocol, Inc., $19,000,000 company recently organized to manufacture gasoline from natural gas, has been announced.

G. G. Gabrielson

Gabrielson has been general counsel of the new company since its organization. He will retain that position and continue his general practice of law in New York and New Jersey.

Eight large companies—The Texas Company, Forest Oil Corporation, Niagara Share Corporation, United Gas Corporation, La Gloria Corporation, Stone and Webster, Inc., Gulf States Oil Company and the Chicago Corporation, are supplying $10,000,000 of the capital required and the Reconstruction Finance Corporation has agreed to loan another $9,000,000.

Directors of the company are George H. Clifford, president, Stone and Webster Service Corporation; Richard J. Dearborn, president, Texaco Development Corporation; Michael Halpern, vice president, The Texas Company; Percy C. Keith, president, Hydrocarbon Research, Inc.; Harry T. Klein, president, The Texas Company; John F. Lynch, vice president, La Gloria Corporation; H. Neil Mallon, president, Dresser Industries, Inc.; W. Frank Miller, vice president, Forest Oil Corporation; J. Fred Schoellkopf IV, president, Niagara Share Corporation, and Gabrielson.

A plant, estimated to cost $15,000,000 will be erected in the vicinity of Brownsville, Texas, where there are numerous natural gas fields. Gasoline and other chemical components will be synthesized from the natural gas by a process developed by Keith and his associates in Hydrocarbon Research.

Johnson joins J. F. Pritchard

Karl Johnson

Karl Johnson, sales engineer representing all divisions of J. F. Pritchard and Company, has recently been transferred to the firm's Chicago office from Tulsa. Johnson has been employed by Pritchard since January 1, shortly after he received his discharge from the Navy. His experience includes a year with a consulting engineering firm in Kansas City, Missouri, and two years with Westinghouse Electric Corporation before entering the Navy.

Mid-Continent representative

The Martin-Decker Corporation, Long Beach, California, announces the appointment of "Mutt" Donovan as Mid-Continent sales and service representative with headquarters at Houston, Texas.

Donovan is well qualified for this position having a background of oilfield experience dating back nearly 20 years. His oil career, which began with the Burma Oil Company, was temporarily interrupted by the war when he served the United States Army Air Corps as lieutenant colonel in the China-Burma-India Theater.

Prior to assuming his new post, "Mutt" spent several months studying Martin-Decker equipment at the company's Long Beach factory and checking field practices.

South American petroleum convention

The central association of the South American Institute of Petroleum, together with the National Sections of the Institute, installed in Argentina, Bolivia, Brazil, Chile, Ecuador, Peru, and Uruguay, are proceeding with preparations for the first South American Petroleum Convention, which will be held in Lima in March, 1947.

The distribution of the rules and regulations of the convention have already been made among those connected with the petroleum industry and the numerous replies received daily by the I.S.A.P. indicate that the convention will be wide in its scope, representatives being present from all countries of North and South America.

According to a notice received from a member of the Uruguay section of the I.S.A.P., Julio Laporte, high official of ANCAP who went to the U. S. on an official mission, there is in that country a great interest in the convention at Lima and leading figures in the petroleum industry in North America are planning on attending.

Among those expressing interest are the departments of War and of Navy, the American Petroleum Institute, the American Association of Petroleum Geologists, Bureau of Mines, Massachusetts Institute of Technology, University of Columbia, and numerous oil companies.

Information regarding the convention can be procured from the "Secciones Nacionals del I.S.A.P." or "Seccion Peruana (Casilla de Correo 889, Lima) or the Comite Ejercutivo del Instituto (Casilla de Correo 414, Montevideo).

Legh-Jones chairman Shell Union

Shell Union Oil Corporation, at a directors' meeting held recently, received the resignation of Sir Frederick Godber as a director of the company. Sir Frederick has been a member of the board since 1922 and chairman since 1937. He was at one time president of Shell Petroleum Corporation at St. Louis. At the meeting the vacancy as chairman of the board of Shell Union was filled by the election of George Legh-Jones, who for many years was president of Shell Oil Company in San Francisco and has been on the board of Shell Union since 1925. Mr. Legh-Jones is at the present time a managing director of Shell Transport and Trading Company. To fill the vacancy on the board caused by the resignation of Godber as director the meeting elected Frank J. Hopwood who, until recently, was president of Asiatic Petroleum Corporation in New York and is now a managing director of Shell Transport and Trading Company.

G. Legh-Jones

Petroleum club formed

Announcement is made by R. L. Keyes, division manager of The Texas Company, New Orleans, of the organization of the Petroleum Club of New Orleans. Keyes is president of the newly formed club.

Keyes stated that the club would occupy clubrooms in the Roosevelt Hotel, and that the approximate opening date is October 15.

Other officers of the club are: Harold C. Teasdel, vice president of The California Company, New Orleans, vice president; Harry Fotiades, independent oil producer, treasurer; Dr. Gordon I. Atwater, chief geologist of William Helis, secretary. Other members of the board are: C. C. Clifton, Louisiana division superintendent, Humble Oil and Refining Company, New Orleans; H. Grady Meador, division manager, Gulf Refining Company; Reese E. Carter, Lynn Oil Company; Robert L. Humphrey, Oil Well Supply Company; William Helis, Jr.; Earl Bateman, drilling contractor, and D. T. McIver, general manager, Freeport Sulphur Company.

Kenneth Crandall, president of The California Company, New Orleans, is chairman of the finance committee, and Robert L. Humphrey is chairman of the house and entertainment committees.

Temporary office of the Petroleum Club has been opened in the Whitney Building where membership applications are being received. Lear P. Barbarich, assistant secretary, will act as manager of the club.

The organization of the club has been under the direction and guidance of Robert L. Humphrey, division tubular representative of the Oil Well Supply Company.

Pittsburgh geologists elect

At a recent meeting of the Pittsburgh Geological Society, Hugh R. Brankstone, geologist, Gulf Oil Corporation, was elected president for the year 1946-47. Other officers include Dr. Shailer S. Philbrick, vice president; W. B. Robinson, secretary, and C. H. Feldmiller, treasurer. Councillors for the year will be Geo. C. Grow, Jr., past president, Raymond E. Birch, Daniel A. Busch, Richard M. Foose, John T. Galey, J. LeRoy Kay, and James H. C. Martens.

During the past year the Society held nine regular meetings, at which a wide range of subject matter was discussed.

Highlights of the Society's special activities included the sponsorship of the annual meeting of the Geological Society of America in December, 1945, the publication for members of the Pittsburgh Geological Society of Dr. Willis' address, and the publication of a monthly news organ. The Society's membership reached 190 during the year, and is composed of diverse geologic interests, such as oil and gas, ceramics, steel, coal, and academic.

Firm incorporated

The Eastern Construction Company, Inc., Dallas, Texas, has been incorporated with the following officers: C. Hobson Dunn, president; J. W. Hall, vice president, and Miss E. A. Anderson, secretary and treasurer.

The purpose of this new company is to take over the work and activities of the old Eastern Construction Company, an unincorporated organization.

Products line projects that have been recently contracted include: Sections 6 and 6a of the Standard Oil Company (Indiana) Whiting, Indiana, Morehead, Minnesota, 8-in. line, and a 60-mile section of 8-in. between Wilmar and Alexandria, Minnesota, for Great Lakes Pipe Line Company.

Parkhill-Wade moves offices

Parkhill-Wade announces the moving of its offices in Los Angeles, California, to 5017 East Anaheim-Telegraph Road. The new mailing address is Box No. 6877, East Los Angeles Branch, Los Angeles 22, California, and the telephone is ANgelus 7121.

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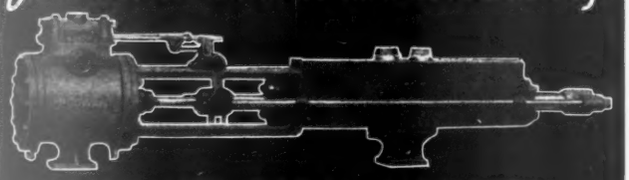

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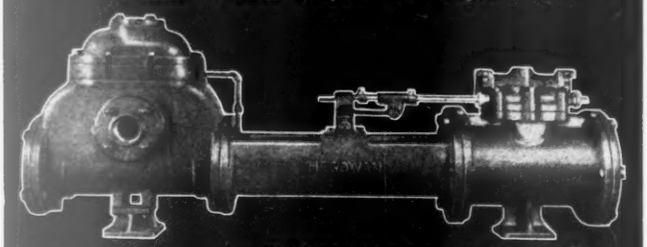

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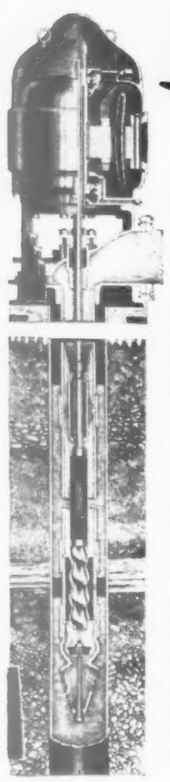

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"Squeezing Water Upward"

SQUEEZES UPKEEP DOWN

PEERLESS HI-LIFT PUMPS

Reg. U.S. Pat. Off.

For low-cost limited water supply demands of multiple industrial uses.

CAPACITIES: 600 to 3300 Gals. per Hour FOR WELLS AS SMALL AS 4" INSIDE DIAMETER

Peerless HI-LIFT is the pump that gives magic wings to water lift, with an ingenious pumping element.

Employing simplicity to the best possible advantage, Peerless has replaced high shaft speed, vibration, and high operating cost, found in most conventional type pumps, with a slow, smooth continuous positive pumping action that literally "squeezes" the water upward.

The only moving part in the pumping element consists of a hard, heat-treated, chrome-plated stainless steel rotor, helically contoured and revolving within a similarly shaped cutless rubber stator. Both of these units are highly resistant to abrasive action.

Buy the pump that "squeezes" water upward and squeezes upkeep down. Investigate today the many possibilities offered you with a Peerless Hi-Lift Pump.

PATENTS: Manufactured under R. Moineau patents, U.S. 1892-217, 2028407 and Reissue 21374. Canadian Patent 352574. By Exclusive License to Robbins and Myers, Inc. Peerless U.S. Patents 2208937, 2338-937 & 2346426. Other Patents pending.

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DISTRIBUTORS IN ALL PRINCIPAL CITIES

New air filter firm

Wm. K. Gregory, for 22 years a key executive in one of the nation's largest air filter companies, has been elected president of Continental Air Filters, Inc., Louisville, Ky.

W. K. Gregory

Continental Air Filters, Inc., a relatively new company in the air-filtration field, devotes itself to industrial air filters and cleaners, with especial emphasis on air cleaners for diesel and gas engines and air compresosrs. A new factory is nearing completion, at 2550 Helm Street, Louisville.

Directors of Continental Air Filters, Inc., are Fred D. Durham, president of C. Lee Cook Manufacturing Company; Raymond Deateale, vice president of Glenmore Distilleries Company; J. F. Shouse, of J. F. Shouse and Company; and Wm. K. Gregory. Officers are Wm. K. Gregory, president; J. F. Shouse, vice president; John Marshall, Jr., secretary, and Hugh M. Rose, treasurer.

McIntyre president Texas Standard

Ralph G. McIntyre, of El Paso, has been elected president of the Standard Oil Company of Texas, a subsidiary of Standard of California, at a board meeting in San Francisco.

McIntyre, previously vice president in charge of manufacturing and sales, succeeds the late A. J. Cunningham, who died in El Paso, August 20. McIntyre went to work for Standard of California in the Richmond (California) refinery in 1910. He later became an auditor and transferred to the Texas firm in that capacity in 1930.

Three new directors, all Houston residents, were named, J. P. Fox, vice president in charge of exploration; C. W. Reith, vice president in charge of production, and H. L. Smith, vice president, secretary and treasurer. Other members of the board are Gage Lund, chairman; H. D. Collier, and McIntyre.

Dedicate new facilities

Le Roi Company, Milwaukee, Wisconsin, announces another step forward in its overall expansion program. The company's Birmingham, Alabama, office formerly handling territorial sales only, has been expanded to full factory branch facilities. A new single story brick and glass block building, at 631 Ninth Street North, has been completed, housing a suite of offices, a display floor, service repair shop, and parts department. The Birmingham branch now becomes the headquarters for the southeastern district comprised of the states of Florida, Georgia, Alabama, Louisiana, Mississippi, Carolina, Tennessee, Kentucky, Virginia, W. Virginia, Arkansas, and West Indies. C. B. Hall, branch manager, announces this major step was taken in the interest of service to Le Roi customers in this territory.

All Le Roi distributors from this territory in addition to seven men from the factory attended the formal opening celebration.

Wallace manager of sales

Appointment of Henry J. Wallace as general manager of sales is announced by United States Steel's National Tube Company. He succeeds W. F. McConnor who recently was elected National Tube vice president in charge of sales.

A native of Pittsburgh, Wallace began with the company in 1928 as a laborer at the Ellwood City, Pennsylvania, plant. Since 1945, he has been sales manager of the Eastern area with offices in New York. Wallace was graduated from Harvard College with a B. A. degree in 1928.

Houston Nomads meet

Nomads' interest in international affairs was commended by Neal Pickett, former mayor of Houston, just returned from 30 months in Europe where he served as a Red Cross field director. "This interest is typical of what will be required of more and more citizens if America is to assume the economic and spiritual leadership which World War II seems to have handed us," Pickett said at the regular August meeting of the Houston Chapter Nomads.

The meeting attracted a large number of international visitors. E. D. Lynton of the French government's Institut du Petrole said five structures had been located between the Pyrenees and Marseille and American equipment is being purchased to carry on the drilling program.

Roldolfo M. Fernandez, with Petroleos Mexicanos, intimated in a brief talk that greatly enlarged oil exploration activities are in store for Mexico when the new administration takes over December 1.

C. L. Clausel told of the organization of California oil pioneers and the opportunity for such a unit in Houston. Although Nomads, as a chapter, could not engage in such organization work, members approved the general idea and if nothing else is done the Houston Chapter plans to invite old timers of the oil business to be special guests of honor at the monthly Nomads meetings.

International guests present were R. N. Posgate, Shell Oil Com-

pany; G. W. van Hillo, Shell Oil Company; C. B. Dykster, Shell; J. B. Rollins, Standard-Vacuum Oil Company; R. M. Fernandez, Petroleos Mexicanos; Rafael R. Davile, Venezuelan Consul representative; Jean Nougaro and E. D. Lynton, Institut du Petrole, Paris, France; D. E. Morgan, Socony-Vacuum of Colombia, and Neal Pickett, American Red Cross.

Chiksan buys Weco

Chiksan Company, Brea, California, announces the acquisition of The Well Equipment Manufacturing Corporation, Houston, Texas, through the purchase of all the corporation's common stock. Operation of the corporation will be continued as a wholly-owned subsidiary of Chiksan Company under the direction of the following officers: W. Edgar Spear, president; H. J. Hagn, vice president and general manager; G. R. Winder, vice president and sales manager; J. H. Robinson, secretary and treasurer, and T. T. Word, Jr., assistant sales manager.

The sale of The Well Equipment Corporation arose out of the desire of C. K. Stillwagon, its president, to retire. Stillwagon has been active head of the corporation since it was founded in 1934 and has agreed to serve in an advisory capacity for a period of one year.

H. E. Boner dies

Halbert Evans Boner, 4067 West Eighth Street, Los Angeles, California, nationally known refining engineer, and for the last 20 years vice president in charge of manufacturing and member of the board of directors of the Macmillian Petroleum Corporation, died Saturday night, August 24. He was 62 years old.

He had been ill for seven days and was stricken with coronary thrombosis while on a vacation at his Lake Arrowhead summer home.

H. E. Boner

Boner completed a course in mechanical engineering at the University of Illinois in 1905 and obtained his master's degree at that school the following year. He went to California in 1907 where he was associated with the engineering department of the Atlas Powder Company. He later did special work on the Redondo Power Plant and in 1911 joined the gasoline testing division of the Union Oil Company. He rose to the position of assistant manager of manufacturing with this firm and left it in 1920 to go into the refining business for himself.

He built two refineries in Texas, and in 1922 joined with Charles H. Sheldon in forming a Los Angeles firm of consulting refinery engineers. They developed numerous patented refining features.

In 1924 he was retained as a consulting engineer for the Macmillan Petroleum Corporation, and in 1926 joined that company as vice president in charge of manufacturing and member of the board of directors.

Move New York offices

Expansion of engineering and service facilities have necessitated the removal of New York offices of Houdry Process Corporation to new and larger quarters, a statement by R. B. Cragin, vice president, announces. Houdry Process Corporation's New York headquarters are now at 25 Broad Street, New York, New York.

At the New York address are R. B. Cragin, Houdry vice president, together with his staff of commercial development engineers, the Houdry process design and project analysis divisions. Former address was 115 Broadway, New York.

The change will not affect other divisions of the organization. These include offices at Wilmington, Delaware, and Philadelphia, Pennsylvania, laboratories at Marcus Hook, Pennsylvania, and catalyst manufacturing plants at Paulsboro, New Jersey.

Pressure Weld moves headquarters

The Pressure Weld Company of Houston, Texas, announces the removal of its offices from 421 Niels Esperson Building, Houston, to the 8th Floor, El Paso National Bank Building, El Paso, Texas. The office is under the management of E. P. Jones.

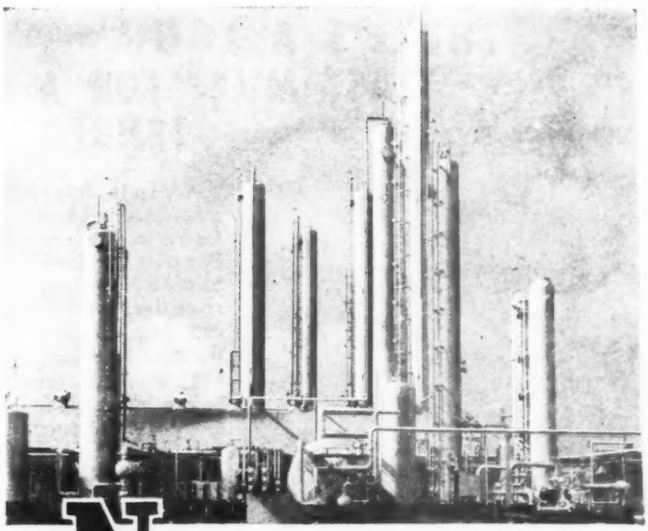
The move to El Paso of the personnel and equipment of the Pressure Weld Company will facilitate operations on the El Paso Natural Gas Company pipe line from West Texas to California, it is announced.

F. D. Smith promoted

Appointment of F. D. Smith as assistant to the general manager of sales for Oil Well Supply Company, Dallas, Texas, is announced by this U. S. Steel Corporation subsidiary.

A native of Marietta, Ohio, Smith has been associated with "Oilwell" for 18 years, beginning in 1928 in the company's Owensboro, Kentucky, store.

On January 1, 1944, Smith was transferred to Dallas, headquarters of Oil Well Supply Company, as supervisor of the general sales department. He will continue to reside in Dallas.



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REPRESSURING

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Long-term effectiveness has made FLORITE the approved drying agent for various operations in the treatment of natural gas. An example is repressuring as done in the plant here illustrated. Hard, granular, stable, FLORITE selectively adsorbs water up to 20% of its own weight, and is regenerated by heating to 350°F. More economical than other granular desiccants because of longer life under the conditions of use, lower in initial cost than most, equal or superior to any in all-round performance, FLORITE is used to advantage in the drying of propane, butane, gasoline, air, nitrogen carbon dioxide, various refrigerants, and other fluids.

Correspondence is invited.

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This process can be continued indefinitely. Replacement bearings and spare parts are always available. Also, the unit is constructed to take the rough handling of moving, installation and operation.

For this reason, producers—large and small—feel that they have made a good investment when they buy Jensens. Check with Jensen owners, your dealer, or write us and stretch that long "Last Mile" into more profit.

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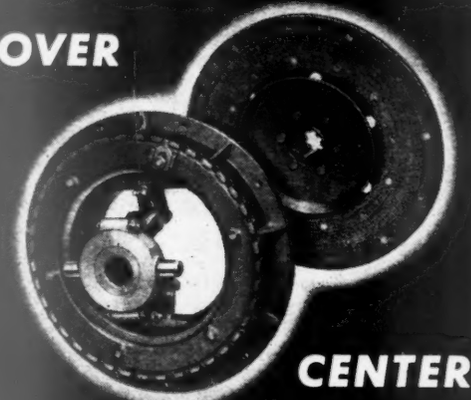

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HIGH TORQUE
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* Anti-friction ROLLER CAMS — an exclusive feature — make ROCKFORD Over-Center CLUTCH operation extremely easy. A light pressure, lever controlled, toggle-joint arrangement moves the high point of the cams "over center".

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables dimensions and complete specifications.

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Continuous seamless pipe mill

Developed by National Tube Company engineers, the world's first continuous seamless pipe mill is scheduled for installation at the Lorain, Ohio, plant of this United States Steel subsidiary.

Long identified with hot rolled strip and sheet mills, the continuous rolling process will be employed for the first time at Lorain to turn out long lengths of steel pipe without welds as fast as 2000 ft. per min.

The new process eliminates several steps in the conventional method of making seamless pipe. In standard practice, a solid round steel bar, heated white hot, undergoes five separate operations to be transformed into pipe. The Lorain innovation combines most of these into one step.

The conventional method starts with the first piercing operation in which an opening is formed lengthwise through the solid bar. Then comes the second piercer, in which the opening is enlarged; the high mill, which produces a uniform wall thickness in the pipe; reeling, to attain perfection in the pipe's surfaces; and finally the sizing rolls, where the product attains its desired diameter and length.

In the continuous seamless mill, the innovation comes after the first piercing operation, which remains unchanged. After the first piercing, the shell is processed through a nine-stand continuous rolling mill, which accomplishes the same results as several steps in present practice.

The conventional seamless mill moves its products sidewise down through the several operations. The continuous mill will operate as a straight-line production unit.

The new Lorain mill is designed to make small-size seamless products, ranging from 2-in. boiler tubes to 4½-in. standard pipe.

New machines installed

Installation of new gun boring machines, for boring of drill collars and kellys, has been completed at the American Iron and Machine Works Company in Oklahoma City, Oklahoma.

Also installed by "American" is a new thread miller for milling threads of drill collars and kellys.

Joins A. O. Smith

W. Stuart Johnson has joined the A. O. Smith Corporation as manager of hydraulic products sales in the Pacific Coast district. He will make his headquarters in the Los Angeles office of the company. Johnson previously was with Southern California Edison, Inc., as engineer in charge of pumping equipment. He was a major in the war, serving as a production engineering officer with the air technical service command. Prior to his war service, he was associated with the Byron Jackson Company and Ingersoll-Rand Company.

W. S. Johnson

Lago president resigns

Lloyd Gaston Smith, of Manhasset, New York, has resigned as president and general manager of Lago Oil and Transport Company, Aruba, Netherlands, West Indies, to join the Foreign Refining Coordination Department of Standard Oil Company (New Jersey).

Succeeding Smith at Lago, an affiliate of Jersey Standard, will be John J. Horigan, of Norwich, Connecticut, who has been a director of Lago since January, 1942. Smith, a graduate in mechanical engineering from the University of Illinois, has been an oilman since 1913. Horigan, a graduate in civil engineering from Yale, has been associated with the petroleum industry since 1920.

W. H. Pullman dies

Known to thousands of Texas oilmen through his work as membership secretary of the Texas Mid-Continent Oil and Gas Association, William H. Pullman, 57, died recently in Dallas, Texas.

Pullman was the oldest member of the Texas Mid-Continent staff in point of service, having joined the association soon after its organization in 1919 as office manager. He became membership secretary in 1936, his duties making him one of the best known oil association representatives in the Mid-Continent and Gulf Coast areas.

Powell heads new company

Fred Powell, manager of the refining division at Standard of California's El Segundo plant, has been appointed president of the recently formed California Refining Company.

The new corporation was organized under the terms of an agreement now awaiting approval by the stockholders of Barber Asphalt Company. Standard of California and Barber will be stockholders of the new company, which will operate the latter's marine terminal and other facilities near Perth Amboy, New Jersey.

Sun Beaumont laboratory moved

The Sun Oil Company production laboratory, 605 Pine Street, Beaumont, Texas, was moved August 1 to 950 Bowie Street, Beaumont.

W. A. Gresh

Flotrol general manager

William A. Gresh has been named vice president and general manager of Flotrol Systems, Inc., Tulsa, according to an announcement by Warner Lewis, president.

Gresh, as secretary-treasurer of Flotrol, had made his headquarters in New York City and Washington, D. C., during the war. When Flotrol was moved from New York to Tulsa, Gresh was brought to Tulsa in the new capacity of vice president and general manager.

Holland incorporates

The Holland Construction Company, Tulsa, Oklahoma, pipe line contractors, has been incorporated under the laws of Oklahoma. President of the corporation is H. T. "Bus" Holland, Jr., who founded the company seven years ago. Holland previously spent five years with J. F. Pritchard and Company and also had long experience with the Ford, Bacon and Davis construction organization.

G. G. "Tuffy" Griffis, vice president of the Tulsa firm, has had more than 25 years' experience in pipe line construction work in the United States, Alaska, and South America. He was formerly with the Swinerton and Walberg and the S. D. Bechtel construction companies. Secretary and treasurer of the company is V. M. Holland.

Research engineer for Cook

The Cook Electric Company, Chicago, Illinois, announces the addition of Edward E. Schultz to the engineering staff of its new division, Cook Research Laboratories, devoted to studies of major physical problems involving industrial processing and instrumentation. Schultz will assist in directing research on transient motion measuring instruments, flow controls, pressures switches, and aircraft controls involving electronic, hydraulic, and mechanical systems.

A graduate of Northwestern University's School of electrical Engineering, Schultz brings a broad background of experience to Cook Research Laboratories. He has been associated with Joseph T. Ryerson Steel Company, the National Broadcasting Company, and during the war was chief engineer of Press Wireless and the Radio Craftsmen, Inc.

To new posts

I. K. Farley has been named petroleum industry sales manager of the Brown Instrument Company, Philadelphia, it is announced by L. Morton Morley, vice president and general sales manager.

R. A. Schlegel has been transferred from the Chicago office of the Brown division of Minneapolis-Honeywell Regulator Company to the New York office where he will assume duties formerly under supervision of Farley.

Farley will coordinate field sales activities in the petroleum industry and conduct market studies. He will make his headquarters at the Philadelphia main office of the company.

Schlegel will have charge of petroleum accounts in the New York area.

National Supply makes promotions

As the company's first major step in building up its sales department for the expanding postwar period, the Spang-Chalfant Division of The National Supply Company made four promotions, it has been announced by George E. Clifford, vice president of the company:

Charles J. Ramsburg, Jr., and Eugene F. Conroy as assistant district managers of the New York office; Edwin A. Booth as Pittsburgh district manager, and Frank W. Morris as manager of the Tulsa district.

Made public relations director

Appointment of Edward C. Logelin, Jr., as director of public relations, United States Steel Corporation subsidiaries, Chicago district, was announced by J. Carlisle MacDonald, assistant to chairman of the board, United States Steel Corporation. He succeeds Arthur C. Wilby, who was elected vice president, United States Steel Corporation of Delaware, August 14.

Logelin has been principal assistant to MacDonald since 1943. Born and educated in Chicago, he has been associated with United States Steel since March 1930, when he began in the advertising department of Universal Atlas Cement Company.

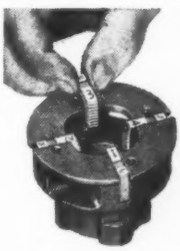
Pittsburgh Equitable new chief engineer

E. R. Gilmore, who has been chief engineer of Emco products, has been appointed chief engineer of the Pittsburgh Equitable Meter Division of Rockwell Manufacturing Company.

Gilmore will be in charge of engineering and development of the meters and regulators built by the division for the control of gas, gasoline and oil.

You thread small pipe with least effort with this tough little RIDGID No. 0R

● Speedy and a worksaver, when you want to cut perfect threads on ⅛" to 1" pipe. This smart steel-and-malleable internal ratchet threader has precision-made heat-treated tool-steel dies, each factory tested . . . for smooth fast threading. Die heads snap in from either side, can't fall out. No special dies needed for close-to-wall work. No. 0R, ⅛" to 1"; No. 11R, ⅛" to 1¼." You'll like these durable efficient RIDGIDs for small pipe. Ask your Supply House.



Chasers easily reverse for close-to-wall threads.

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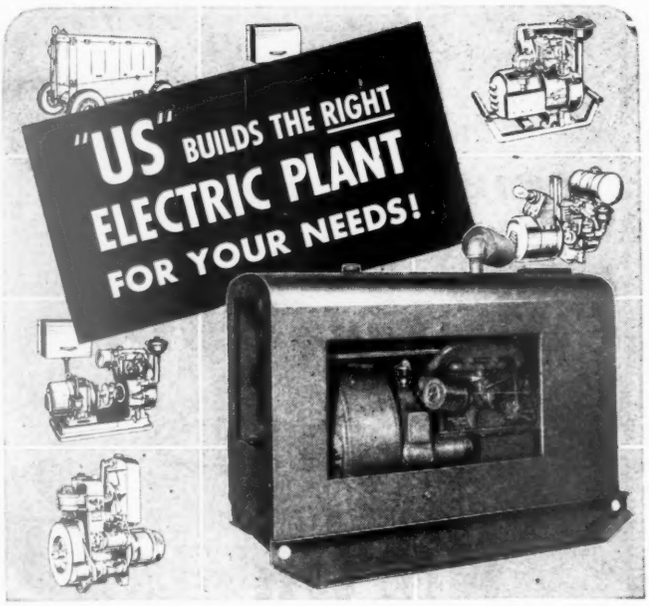

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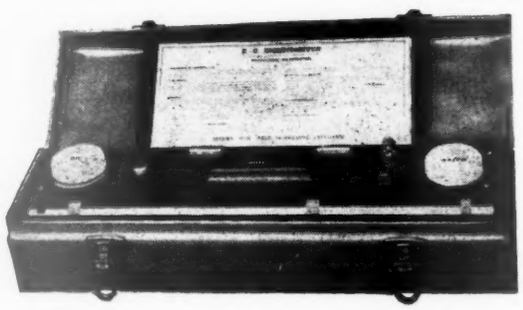

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Our rental customers receive the E-C Inclinometer in this compact carrying case. They are assured of the security and accessibility of the contents.

The E-C Inclinometer is made of K-Monel Metal, which is the highest possible grade material and lends itself to great accuracy in fabrication. The carrying case also is of K-Monel Metal sheets and N. P. brass.

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Offices: Philadelphia, Pa.; Houston, Corpus Christi, Falfurrias, Marshall, Odessa, Texas; Lafayette, La.; Long Beach, Bakersfield, Calif.; Oklahoma City, Okla.; Casper, Wyo.

W.P.R.A. Shreveport meeting

The Western Petroleum Refiners Association, Tulsa, Oklahoma, has completed arrangements for the fourth of its 1946 Regional Technical meetings. This meeting will be held in Shreveport, Louisiana, at the Washington-Youree Hotel on October 11.

The subject selected for this meeting will be entitled, "Recent Advances in Catalytic Desulphurization of Refinery and Natural Gasolines." Speakers will be M. W. Conn and George M. Brooner, Phillips Petroleum Company, Bartlesville, Oklahoma.

Much of the data to be discussed will be of wartime origin and will be heard by many for the first time since secrecy restrictions have been removed.

During the war years, some of the larger companies installed catalytic cracking and other facilities for the manufacture of high octane aviation gasolines. In many instances, this equipment can be adjusted to the peacetime manufacture of improved motor fuels. Some of the smaller refiners who could not install such equipment are now faced with the problem of upgrading their fuels to meet the impending octane rise for such fuels, as influenced by the current curtailment of tetraethyl lead allotted to them.

This discussion will outline ways in which many of the small refiners, by using present existing equipment, can with a minimum of cost, be afforded a means of meeting competitive requirements in the future.

Morris retires from active duty

William J. Morris retired as active executive head of the Continental Supply Company at Dallas, Texas, August 31, the day he completed 40 years with The Youngstown Sheet and Tube Company and its sales subsidiary.

Morris, a native of Hubbard, Ohio, joined Th Youngstown Sheet and Tube Company as a co clerk in the accounting department Septembe 1, 1906. The company then employed 2000 an was capitalized at $3,800,000.

Within a few years Morris was vice presiden in charge of finances. For a number of years h was principal adviser to James A. Campbel one of the founders and second president of th company, and later to Frank Purnell, presen president.

In the early 1930s Morris was sent to Dalla to head Continental, which faced grave organization and operating problems.

William J. Morris

Morris, although retiring from active duties, will continue as chairman of the board and will be available when needed in an advisory or consulting capacity.

Oklahoma chemical engineers meeting

The Oklahoma Chemical Engineering Society is holding an all-day technical meeting in Bartlesville, Oklahoma, October 12. An afternoon and an evening session are planned. The afternoon session will present four chemical engineering papers. The speakers and their topics will be Dr. Karl Hachmuth, Phillips Petroleum Company, "Use of Activity Coefficients in Correlating Vapor Liquid Equilibria"; Professor L. F. Sheerar, Oklahoma A. & M. College, "Oklahoma Resources for Chemical Industries"; Dr. H. L. Hayes, "Butane Dehydrogenation" and one other speaker to be announced later.

A speaker of national prominence is planned for the evening session, speaking on a topic of general scientific interest.

The Oklahoma Chemical Engineering Society was organized in October, 1945, by a group of members of the American Institute of Chemical Engineers in the State of Oklahoma.

The officers are: Chairman: H. R. Legatski, Natural Gasoline Department, Phillips Petroleum Company, Bartlesville, Oklahoma.

Vice chairman: H. L. Malakoff, chemical research division, Cities Service Oil Company, Tallant, Oklahoma.

Secretary: G. H. Hanson, Research Department, Phillips Petroleum Company, Bartlesville.

The affairs of the organization are governed by an executive committee composed of the officers mentioned above and the following members at large: L. K. Cecil, Infilco Company, Tulsa, Oklahoma, and J. W. Latchum, natural gasoline department, Phillips Petroleum Company, Bartlesville.

Arrangements for the fall meeting are being made by a committee consisting of G. L. Meyers, chairman, Virgil Scarth, and J. W. Latchum.

Steele joins Oil Base

E. N. Steele has been appointed California coastal territory representative for Oil Base, Inc. Prior to joining Oil Base, Inc., Steele had been head drilling engineer for Bell and Loffland drilling contractors, California division superintendent for Baroid Sales division, and manager of Antelope Materials Company division, Macco Construction Company.

Directs public relations

President S. J. Dickey of General Petroleum Corporation, the Pacific Coast affiliate of Socony-Vacuum Oil Company, has announced the appointment of Wallace B. Curtis to the newly created position of public relations director. Promoted from the post of advertising manager, which he has held for the last 14 years, Curtis has a previous background of eight years in other marketing activities for the same company, preceded by several years of promotion, advertising, and public relations work in the commercial aviation and resort fields. He was for some time associated with the Curry interests in Yosemite National Park and pioneered in the flying service between Los Angeles and Catalina Island. He is an engineering graduate of Stanford University and served as an engineering officer in the United States Navy during the first World War.

Curtis will make his headquarters in the General Petroleum executive offices at Los Angeles.

Yellow traveling blocks

Announcement is made by the Regan Forge and Engineering Company, San Pedro, California, manufacturers of oil field equipment, that for safety reasons, all Regan traveling blocks will be painted a bright yellow in the future. These blocks have been painted a "Regan Red" since the company began making them many years ago. It has, however, been found that yellow color reflects more light than red in low illumination, which makes the blocks easier to see at night and in foggy weather.

Petroleum chemist officers

At the business session, which ended the two-day program of the Petroleum Division of the American Chemical Society, Dr. Gustav Egloff of Universal Oil Products Company was elected chairman, and Dr. A. N. Sachanen of Socony-Vacuum Oil Company was elected vice chairman. Cary Wagner, consulting chemist, was re-elected secretary-treasurer.

Dr. S. S. Kurtz, Jr., of the Sun Oil Company, the retiring chairman of the division, and Dr. W. E. Bradley, of the Union Oil Company of California, were elected members of the executive committee.

Byron Jackson buys firm

Byron Jackson Company announces the acquisition of the Butte Pump and Motor Works in Chico, California. The acquired business was established in 1925 as the Gas and Electric Service Company and has had a consistent growth since that time. The name was changed to Butte Pump and Motor Works in 1934 and the business at the present time consists, in addition to acting as a dealer of Byron Jackson Company pumps, of rewinding of motors, electrical wiring, servicing of neon signs, sale of appliances such as refrigerators, washing machines, radios, etc. A modern two-story concrete building has recently been completed to house the business at Ninth and Broadway in Chico.

It is contemplated that the business will be expanded and operated as a division of Byron Jackson Company with no change in name.

A. F. Vonnegut, who has been with Byron Jackson Company for 16 years, will assume charge as manager, with no other changes in personnel.

This acquisition provides Byron Jackson Company with assembly, repair and service facilities and an existing organization to service the northern part of California and southern Oregon.

Here's the Accurate Way to take Wire Line Measurements

Easy to use ● Light and handy to carry ● No more "Stringing-in" Guess Work ●

Hundreds of Cavins Depthometers are in successful service giving their owners direct-reading, accurate well measurements. This strong, simple device comes in a handy carrying case (weighs only 17 pounds)—is put on the line in a few seconds, and tells you where bottom is quickly and dependably. —Write for folder to The Cavins Co., 2853 Cherry Ave., Long Beach 6, California.

Gives you accurate depth ● Direct reading ● Pays for itself in a short time ●

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Here's the FILTER that gives you....

20 TIMES*

More Actual Filtering Area

* NUGENT Duplex Fuel Oil Filters provide 20 times greater filtering area than most filters of comparable size.

It stands to reason that the more actual filtering area in a filter the greater the interval between cleaning and also the greater will be degree of protection. This greater filtering area in Nugent Duplex Fuel Oil Filters enables you to maintain *extra* protection on fuel oil lines year in and year out.

Nugent Duplex Filters are specially designed units, built for rugged, long-life service. The special woven, acid resisting, lintless, filter element removes particles as small as .0017" . . . a feature that means *cleaner* oil. Duplex units are offered in a wide range of sizes . . . write today for details.

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Est. 1897

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FOCAL RAY EMPIRE

OIL FIELD LANTERNS

(MODEL 940 UL)

● SPARKPROOF construction throughout. Light socket ejects broken bulbs. Wide adjusting range —from beam to floodlight at turn of lens. Flexible Directional Beam. Wireless Sliding Switch. Easy Grip Handle. Runs on 6-Volt Lantern Battery. ● *At Your Supply Distributor, or write for immediate delivery.*

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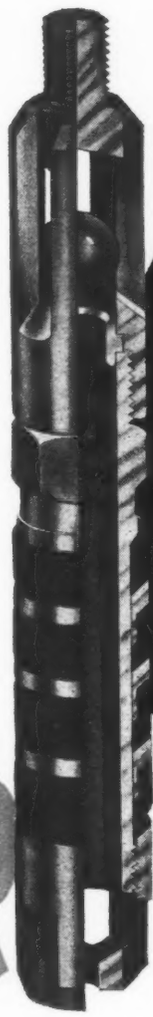
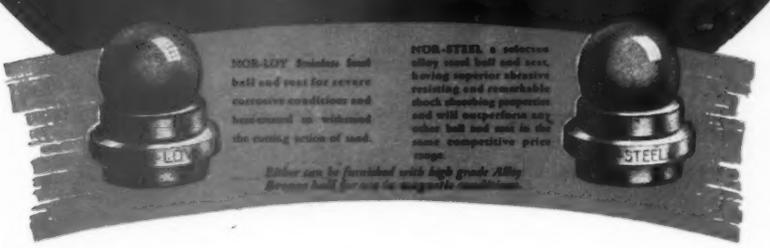
NORRIS BLUE RIBBON WORKING BARRELS

The Barrel with the **BLUE** *Finish*



NORRIS *Blue Ribbon*

Seamless Steel Working Barrels—*"The Barrel with the BLUE Finish"* has the highest inside finish of any barrel on the market. Reamed and polished, insures extremely long valve cup life. The tolerances to which they are held are well within A. P. I. Standards. Made from the highest quality seamless cold drawn steel tubes, manufactured to NORRIS exacting standards of precision, with careful inspections guarding each step in manufacture, they are free from all defects. Also furnished in bronze for corrosive conditions, of the same precision manufacture to A. P. I. Standards. For over half a century the name W. C. NORRIS has been synonymous with highest quality in oil tools; *for maximum production, longer life and freedom from breakdowns, specify NORRIS Blue Ribbon—the prize winner among working barrels.*



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QUALITY NORRIS MAKES FRIENDS

EXPORT OFFICE
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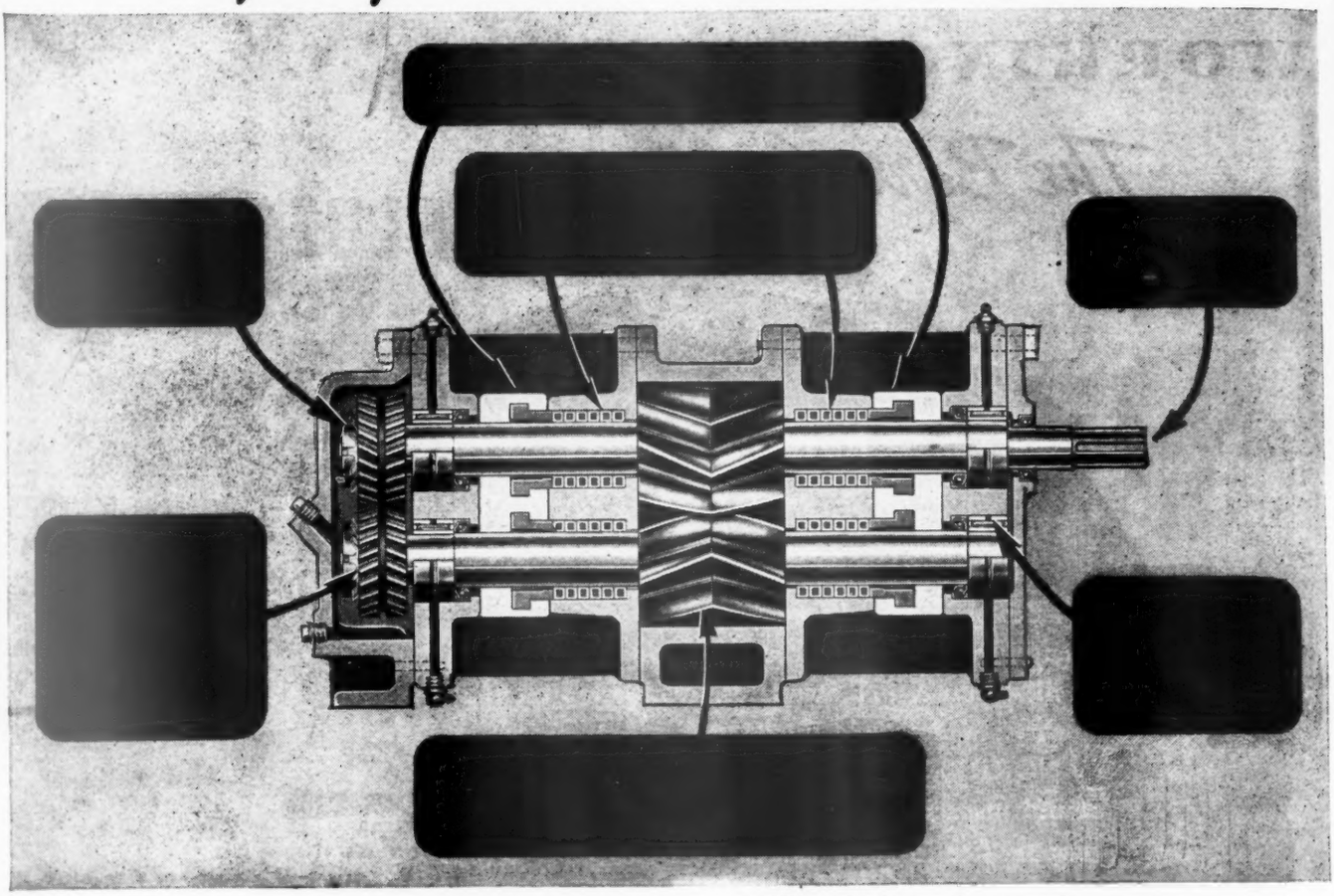
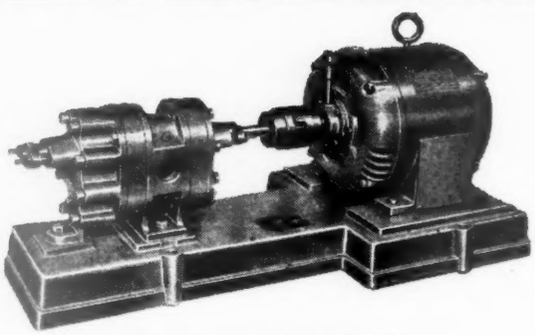
GEAREX ROTARY PUMPS

Give you these PLUS VALUES





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CAPACITIES: 1 to 550 g.p.m.

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DISCHARGE: 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water

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For higher pressures and capacities use
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SIER-BATH Gearex Rotary Pumps last longer and run quieter because they are made to the same high accuracy standards as Sier-Bath Precision Gears. Their low pitch line speed results in more efficient operation. Their special design prevents trapping. Sier-Bath Gearex Pumps are available in horizontal and vertical models, in steel or special alloys, and with jacketed bodies for high temperature applications or where heat must be applied. Write for detailed information.

See our Booth No. 568 at the Power Show in Grand Central Palace, New York, in December.

FOUNDED 1905 **MEMBER OF A. G. M. A.**

Sier-Bath Gear Co. Inc.

The Petroleum Engineer, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, seventh floor Irwin-Keasler Building, Dallas, Texas. Subscription price, $2.00 per year, $3.00 for two years, 25¢ a copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the Act of March 3, 1879.

with Aeroseal*Q

From oil production centers throughout the country, reports testify to the advantages of proper mud control with Cyanamid's AEROSEAL Q.

A "two-miler" recently was completed in only 191 days actual drilling time! A record in itself—considering the difficulties encountered beyond the 10,000 foot level—it emphasizes the importance of controlled drilling mud in deep-well operations, and reflects the trend to offset increases in per-day drilling costs by reducing the total number of drilling days.

AEROSEAL Q Drilling Mud Conditioning Compound offers a reliable means of reducing total drilling costs and time by assuring low water loss and a thin, tight mud cake at all times. Furthermore, its effectiveness under *all* conditions gives added assurance of faster drilling of straight, full-gage holes—with consequent freedom from breakdowns due to tight hole and stuck pipe.

A highly skilled technical staff—plus large, modern production facilities enable Cyanamid to produce AEROSEAL Q in quantities to meet large requirements. Additional information or technical assistance may be had by contacting American Cyanamid Company, 229 Shell Bldg., Houston, Texas, or Azusa, California. *Reg. U. S. Pat. Off.

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"IS YOUR DRILLING MUD A GOOD MIXER?" asks General Mud. "If it isn't, you can depend upon AEROSEAL Q to adjust its weight, viscosity and other properties to meet conditions in any given well. Now is the time to investigate the all-important advantages of better mud control with AEROSEAL Q!"

AMERICAN Cyanamid COMPANY

Industrial Chemicals Division

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Industrial Power Division
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Best operating conditions
Lowest maintenance
Most efficient lifting
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Greatest satisfaction

Whether you use a central lease electric generating plant or individual engines, you do away with

Horsepower-eating rod lines
Cumbersome dummies
Troublesome swings
Dangerous hookoffs
Inefficient hold-ups and hold-downs
Cluttered-up leases
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Unbalance of the central system

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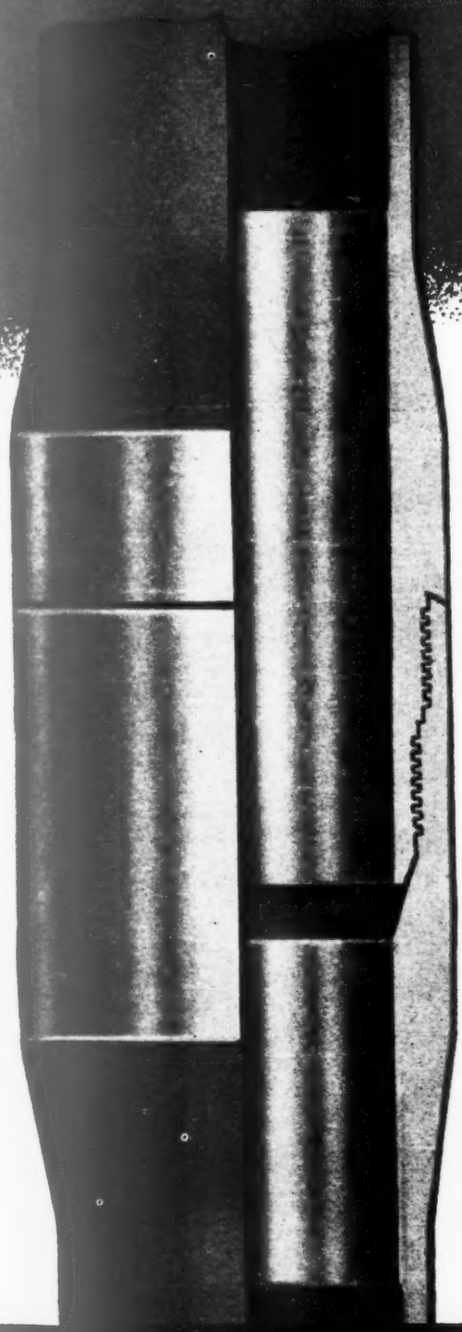
BETHLEHEM STEEL

Bethlehem Basically-Balanced Rod Pumping Systems

The HYDRIL Type "S" TUBING JOINT



WILL NOT LEAK

Double pressure-seal (tapered inside shoulder and undercut outer shoulder) makes joint permanently fluid-tight to both internal and external pressures. Hydraulically smooth —no gap to invite corrosion and cause turbulence and impeded flow.

MAKES UP EASIER

Two-step thread is practically self-stabbing. One spin of the rope and one jerk of the tongs make it up. Cannot cross-thread. Cannot gall. Cannot be overtonged . . . box will not bell; pin will not collapse.

RUNS EASIER

No collar to hang up. Smaller in diameter than A.P.I. coupling, provides greater clearance, runs in or out of hole quicker and easier. Beveled shoulder runs easier through packers, takes less power. Packers last longer.

EASIER TO SWAB

Full inside diameter makes it easier to swab, easier to set packers. No gap at the joint to ruin the seal if packer sets at that spot.

HAS GREATER STRENGTH

Machined, inside and out, to exact dimensions. Square thread gives better bearing. Two-step thread develops full strength of metal in joint. The HYDRIL Type "S" JOINT IS AS STRONG AS THE PIPE!

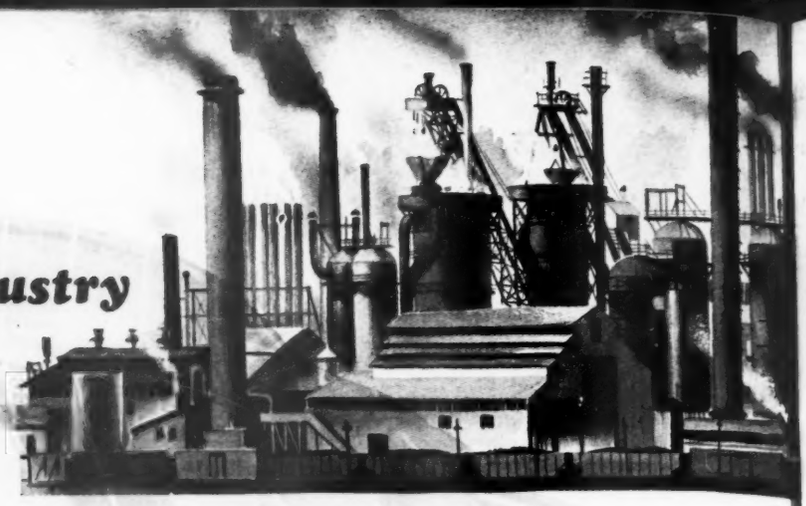
HYDRIL MADE *Means* TOP GRADE

HYDRIL COMPANY · 714 W. OLYMPIC BOULEVARD, LOS ANGELES

listen!

WHAT'S THAT HUM YOU HEAR?

it's the crescendo of industry



heightening the demand for more lube oil!

As American industry shifts into higher gear, as automobile production and air travel reach new highs, and as more and more machinery hums in a rebuilt Europe—the demand for premium lube oils is mounting rapidly.

• Those refiners who plan now for early construction of lube oil facilities obviously will be in an advantageous position to profit briskly, as the lube oil demand increases.

• Lummus service includes every stage of process development, plant design, construction and initial operation. With complete facilities for pilot plant and semi-commercial operation, Lummus is equipped to study individual refinery conditions with a view to the design and construction of a plant that will give maximum yields of high-grade lube oils at minimum cost.

Lummus has designed and built a large percentage of the world's solvent refining and dewaxing capacity:

14 solvent refining plants now in operation
—3 more under construction;

19 solvent dewaxing plants
—3 more under construction.

THE LUMMUS COMPANY
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long life, low cost lube oil plants

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Write for a copy of "Development of the Postwar Petroleum Refining Picture."

WeldELLS

for example:

precision quarter-marked ends....

Those four points on each end of every WeldELL are small things to look for, but big things to find.

They make it far easier to follow center lines, angles and planes—save time, prevent errors.

Here is a feature that appeals to the practical man—an exclusive feature of WeldELLS—typical of the extra value you get in all Taylor Forge Welding Fittings.

Please note the list of extra-value features opposite. Who can doubt that a job welded with fittings which lack these features does not sacrifice something—in speed of installation, in economy, in soundness, in the lasting satisfaction that goes with using the *best!*

TAYLOR FORGE & PIPE WORKS

General Offices & Works: P. O. Box 485, Chicago
New York Office: 50 Church Street
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WeldELLS alone combine these features:

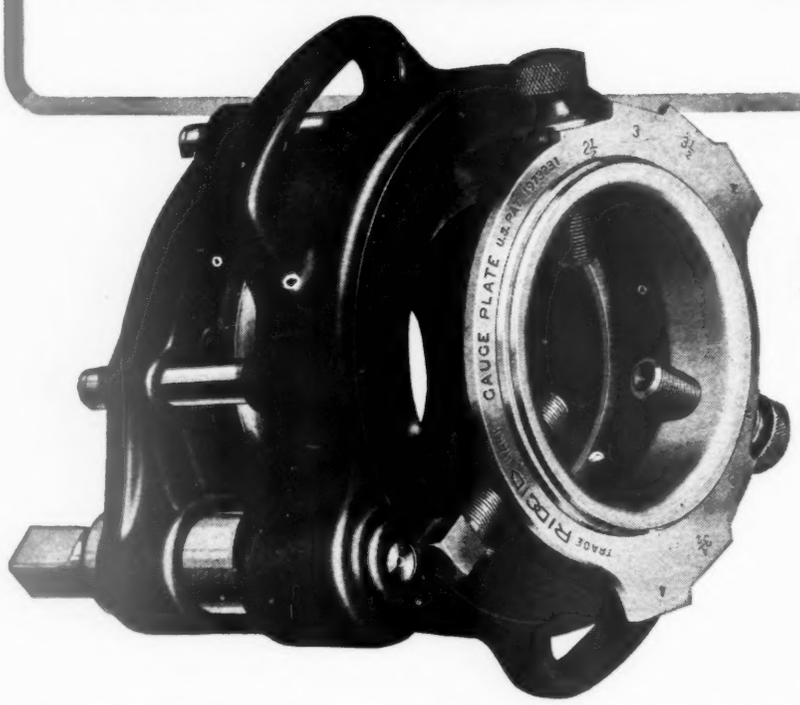
- **Seamless**—greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends** — simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

have everything

At Last!

. . . a much easier-to-handle 2½" to 4" geared Pipe Threader New RIDGID No. 4P

Quick-set workholder—fully enclosed gear.



● Now you can have a 2½" to 4" geared threader you can handle with unusual ease—carry it, put it on pipe; it's got handles you can get hold of and control it with. That's only one of the many RIDGID features of this new 4P die stock that you'll enjoy.

Balanced Loop-handles. Easy to pick up, easy to put straight on pipe—no slipping or tipping over. And easy to carry with one hand. . . .

Quick-setting Workholder. Mistake-proof—you set it to size *before* you put it on pipe, then tighten only one screw. No bushings to bother with or lose. . . .

Easy Pipe Threading. Four sets of 5 high-speed steel dies easily cut clean accurate threads, standard or tapered, drip threads, short nipples. Ratchet handle with each 4P; RIDGID universal drive shaft available for power drive. . . .

Extra Easy Upkeep. Twin-anchored drive shaft turns in oilless bronze bearing—never needs oil. Grease packed gear is fully enclosed, safe for you, safe from dirt and wear.

●

Loop-handles—it's extra easy to put on pipe.

Make sure of these easier-work advantages . . . buy the 4P at your Supply House.

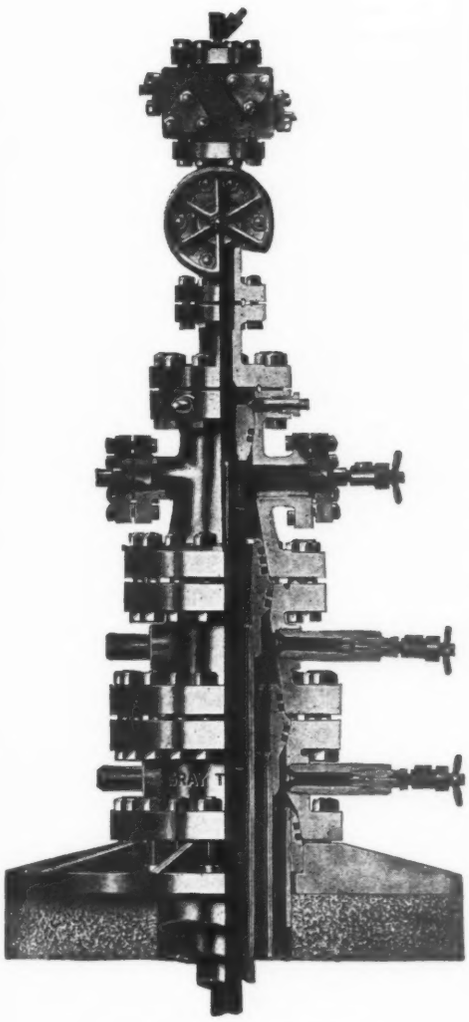
Millions of RIDGID Tools in use

★ RIDGID ★

WORK-SAVER PIPE TOOLS

The Ridge Tool Company
Elyria, Ohio, U. S. A.

SIMPLICITY is the first requisite of well control



Complete Well Head Assembly
Equipped with Composite Manifold,
Valve Removal, Installation and Renewal

Look for the loads that aren't there!

It's a miracle, instead of luck, when large pressure subject areas don't give trouble. In Well Control, as in hydraulics, minimizing pressure subject areas is a first requisite in the efficient control of pressures. Seal for controlling pressures from casing strings should be relatively the same area as that of the casing.

This is accomplished in Gray Systems of Well Control by moving the seal from the large casing head flange areas to smaller casing hanger areas. Casing hangers perform the multiple service of hanging casing and maintaining seals both from within and without the casing they support. Seals are obviously the most important element of a control structure, for the very purpose of a control structure is to captivate or seal that which it controls.

There ar many advanages accruing from this reduction of pressure subject areas. Savings of materials is one, the decreased physical loading of materials gains more strength with less weight —flanges, bolts, valves and control accessories provide proportionately larger factors of safety. Structures are maintained large enough to permit essential operations, while at the same time control devices are small enough to maintain the proper ratio of balance with the casings upon which they are used. As depth increases, casing sizes are reduced to withstand pressures encountered; sizes of surface control equipment are likewise reduced, effecting a consistent balance of the whole.

When you reduce the diameter of the casing head pressure subject area, when you use drilling control equipment of like size with the casing, when tubing master valve is consistent in size with the tubing, flow from which it controls, you reduce the load or pounds of pressure exerted, in many cases as much as 50 per cent.

Simplicity is the first requisite of well control. Look for the loads that aren't there.

GRAY
TOOL COMPANY
HOUSTON

Export Representative: GUY E. DANIELS, 30 Rockefeller Plaza, New York City
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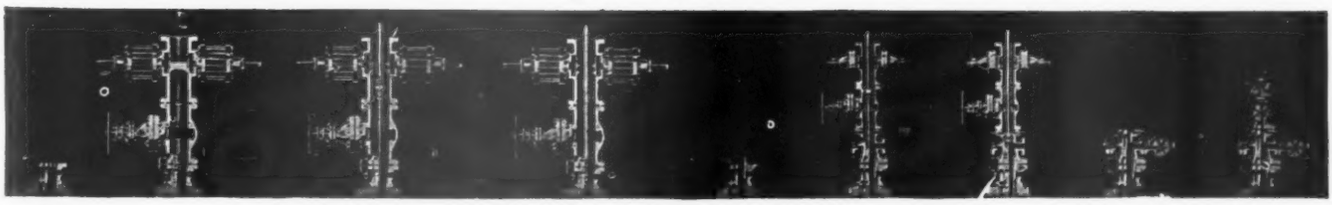
CONTROL DURING AND BETWEEN ALL OPERATIONS WITH GRAY PLANNED PROCEDURE



Casing Head Attached | Drilling | Running Casing | Casing Landed | Drilling Control Equipment Removed | Drilling-in and Running Tubing | Tubing Landed | Control Equipment Removed | Manifold Attached

SHORT-CUT TO *Coring Success!*

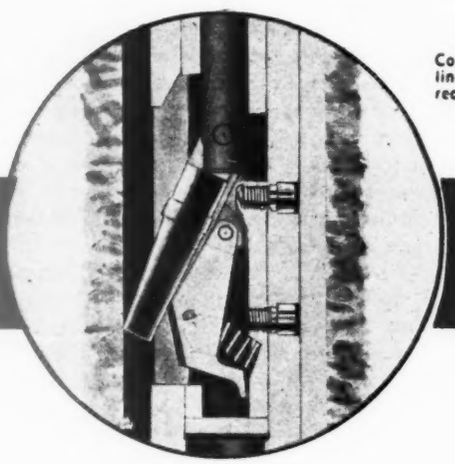
HUNT SIDE WALL CORING TOOL

Proved by thousands of runs, Hunt Side Wall Coring Tools recover uncontaminated cores large enough for quick analysis.

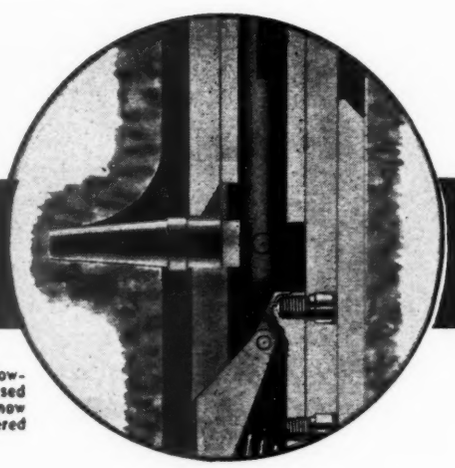
Look at the life-sized core here. It's 1¾" in diameter and 8 inches long. Any number of cores this size . . . or smaller . . . can be quickly and economically taken with the Hunt Side Wall Coring Tool.

The Hunt Side Wall Coring Tool is run in the hole on drill pipe. Cores are recovered by means of the retractable wire line barrel and wire line overshot. Any type of bit desired may be installed on the lower end of the tool for drilling out bridges when necessary. A circulation plug may be dropped into the tool so that circulation can be maintained to the bit whenever desired.

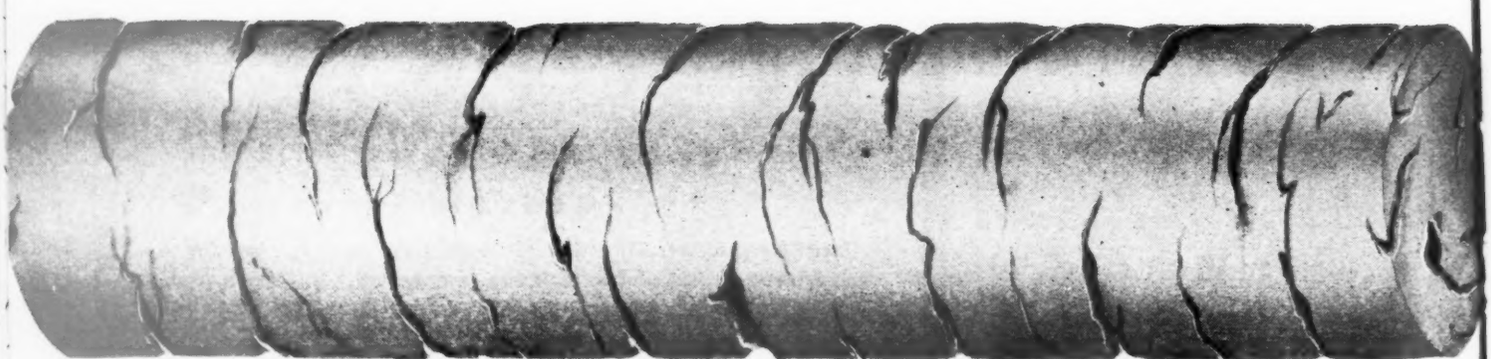
Hunt Side Wall Coring Tools . . . thoroughly proved . . . are your short cut to a true and complete picture of your production possibilities. Find your formations faster, more economically with the Hunt Side Wall Coring Tool. They're available now. West Coast Service by Dunlap Welding and Bit Works, Bakersfield, California.



Core tube deflected, with wire line retractable barrel in position ready to penetrate side wall to take core.



Core tube in side wall after lowering of drill pipe has caused penetration. Drill pipe is now slightly raised and core recovered by wire line.



What can you tell about production possibilities from an 8-inch core? This is a "life-sized" Hunt Side Wall core. Yes, you can get the whole story! And you can lay that story on the checking table faster, more economically with the Hunt Side Wall Coring Tool.

HUNT TOOL COMPANY

FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey

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BECKMAN IR2 INFRARED SPECTROPHOTOMETER

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BECKMAN TECHNICAL LABORATORIES *Bulletin* 153 SOUTH PASADENA, CALIFORNIA

BECKMAN INFRARED SPECTROPHOTOMETER
MODEL IR2

THE BECKMAN IR2 INFRARED SPECTROPHOTOMETER is making possible new analytical and control methods in many of today's industrial processes. Developed originally to simplify plant control methods in the refining of butadiene and aviation gasolines, Infrared equipment proved so valuable in saving time and stepping up the efficiency of plant processing operations that other industries wanted similar Beckman equipment for simplifying their analytical and control problems.

As a result of this widespread demand—and backed by the invaluable experience gained by Beckman engineers in building more Infrared Spectrophotometers than all other makes combined—the Beckman IR2 Spectrophotometer was developed. This instrument, besides embodying the advancements of the original Beckman Infrared instrument, incorporates other advancements that extend the advantages of infrared analytical and control methods to much broader fields of application.

The Beckman IR2 Infrared Spectrophotometer is years ahead of any other infrared equipment because into its design Beckman engineers have incorporated the ideas, user-suggestions and first-hand experience gained from the long period of pioneer work in butadiene and 100-octane applications—two of industry's greatest war-time achievements. To enable you to fully understand the really important advancements incorporated into the IR2, a new twelve page Beckman Bulletin has been issued describing the IR2 in detail. A copy of this Bulletin will gladly be sent you on request. Write today while ample supplies are available. *Beckman Instruments, National Technical Laboratories, South Pasadena 26, Calif.*

A FEW OF THE IR2 ADVANCEMENTS DESCRIBED AND ILLUSTRATED IN THIS BULLETIN

MAXIMUM VERSATILITY: Illustrations and descriptive matter show how the IR2 handles liquid and solid samples as well as gases . . how its light sources, cell holders and other elements are interchangeable . . . how these and other features insure maximum adaptability to varying applications.

ELIMINATION OF FALSE ENERGY AND ZERO DRIFT: This important feature is described, and illustrated with typical data and charts.

ELIMINATION OF TEMPERATURE CORRECTION: The method of thermostatting the instrument against temperature variations is described and the importance of this feature explained.

ELIMINATION OF GALVANOMETERS: Beam modulation, energy receiver and electronic amplifier are described, showing how they eliminate the temperature, non-linearity and vibration difficulties associated with galvanometers.

IN ADDITION, internal views of the instrument, light path diagrams, typical recorded curves and many other valuable IR2 features are contained in this Bulletin. It is an invaluable aid to anyone contemplating the purchase of infrared equipment for it gives detailed facts on the latest infrared advancements!

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"for the production of goods
"as near perfect in design,
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"as shall make them merchantable
"and of a character that will serve
"to establish for this company
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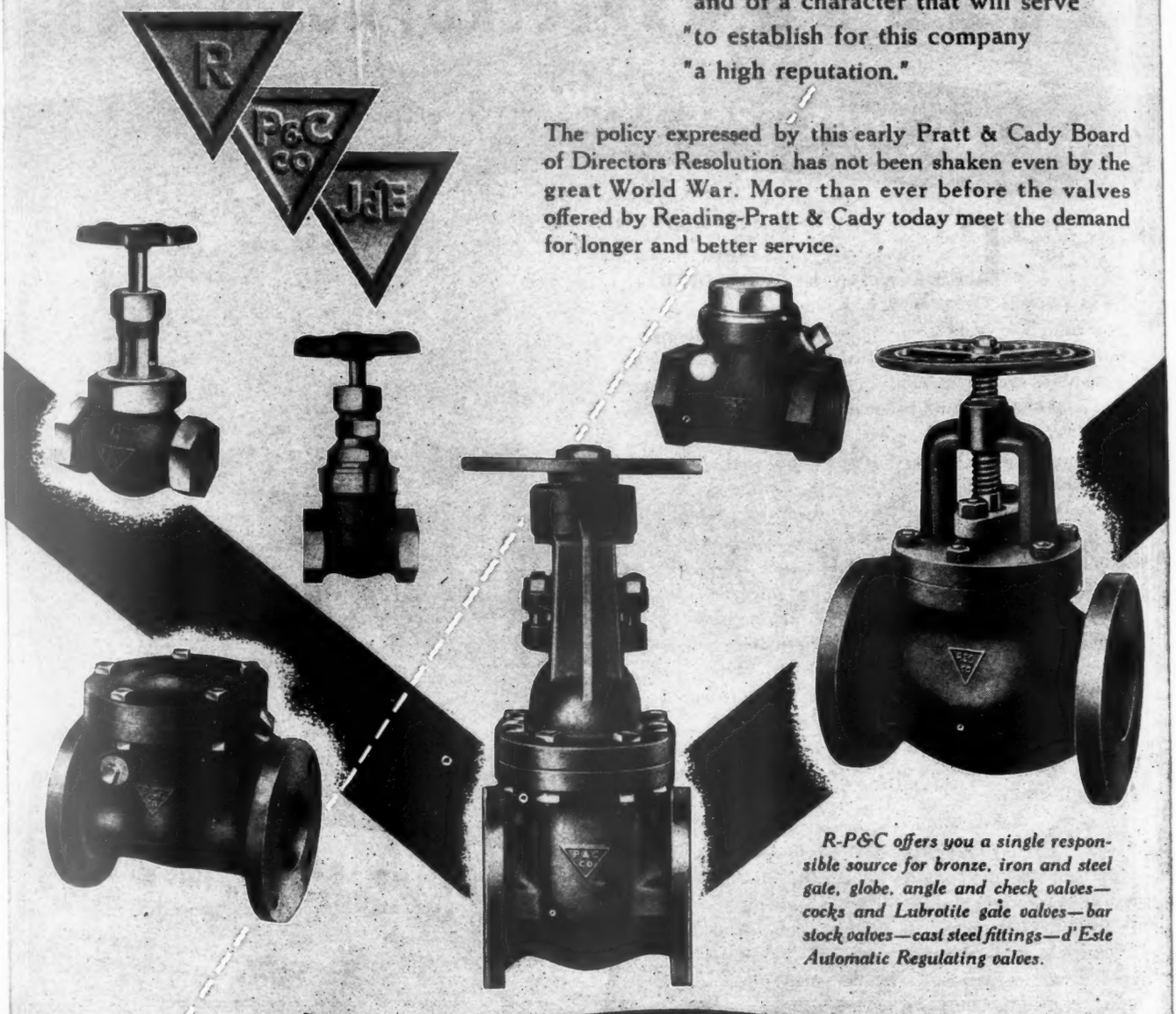
The policy expressed by this early Pratt & Cady Board of Directors Resolution has not been shaken even by the great World War. More than ever before the valves offered by Reading-Pratt & Cady today meet the demand for longer and better service.



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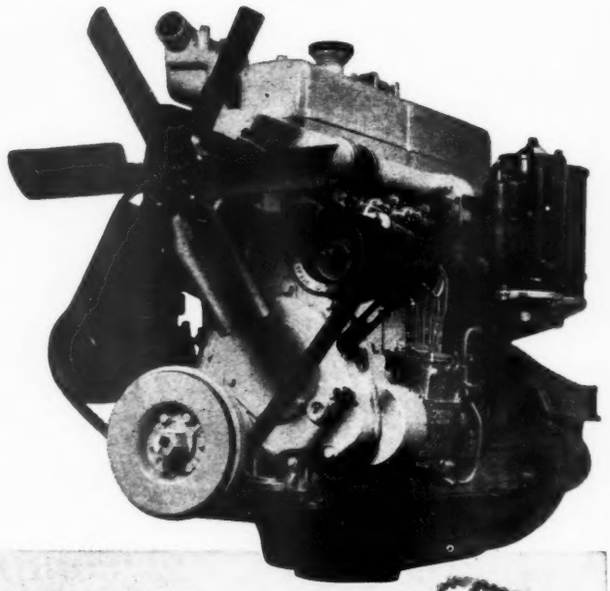

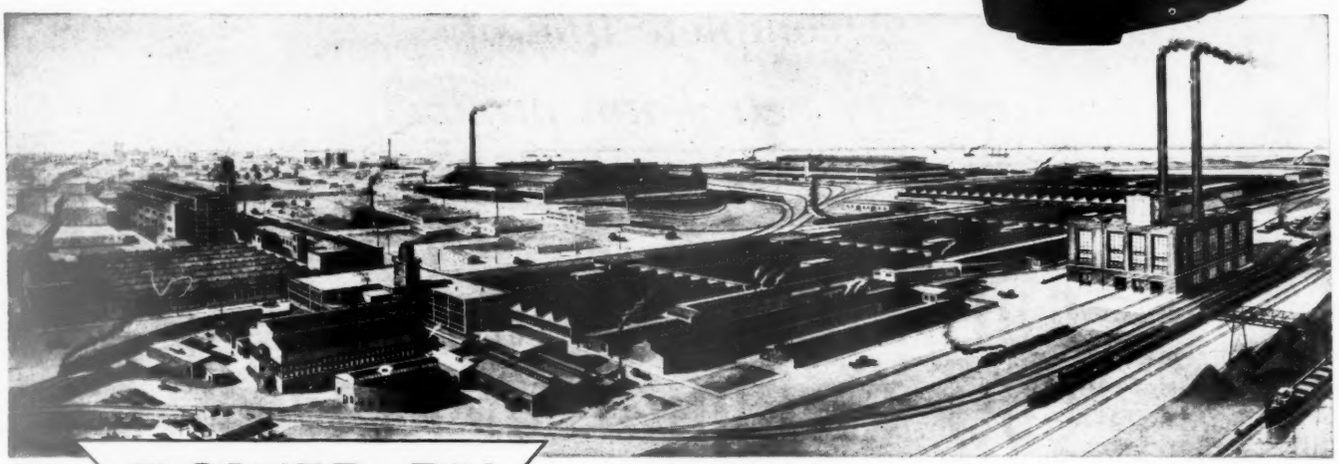

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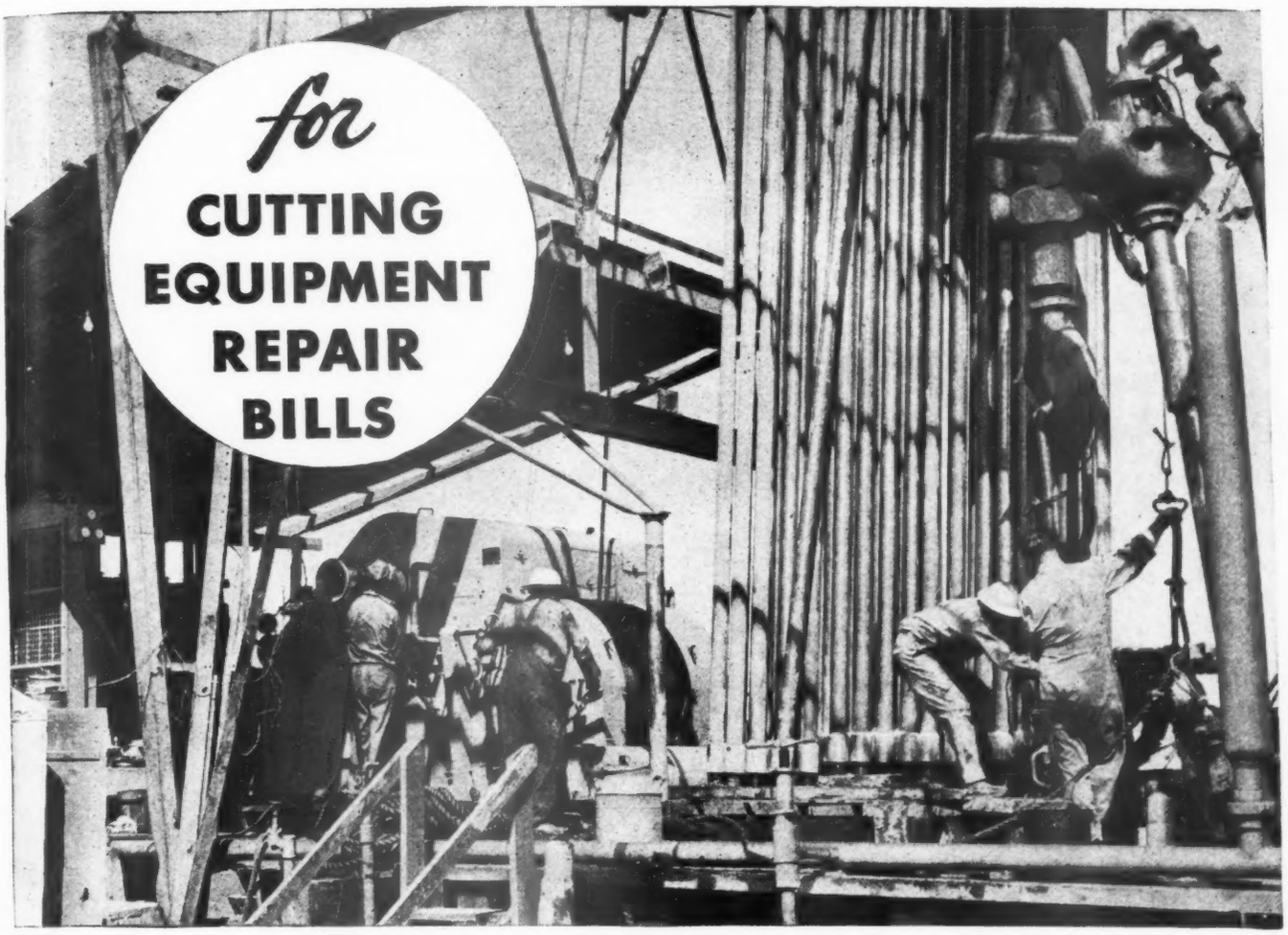

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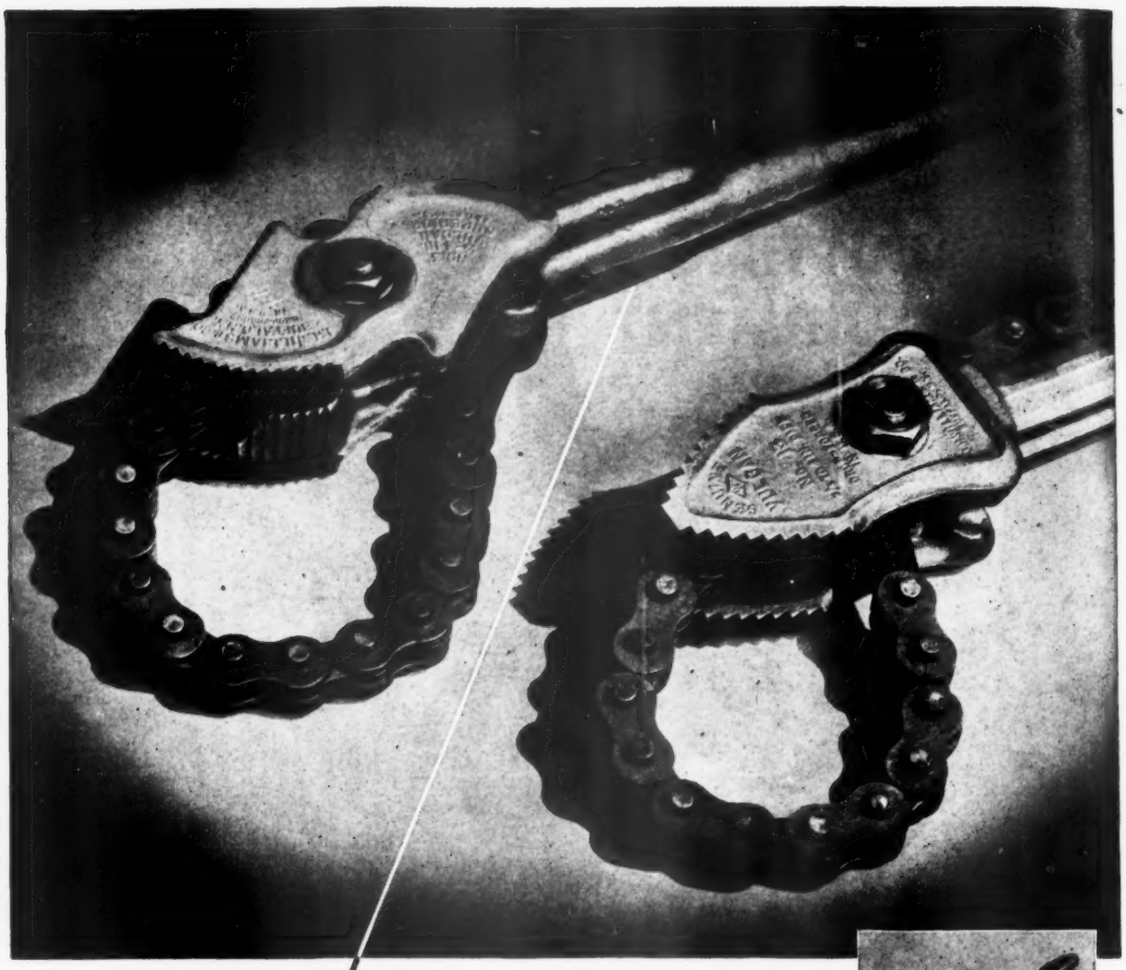

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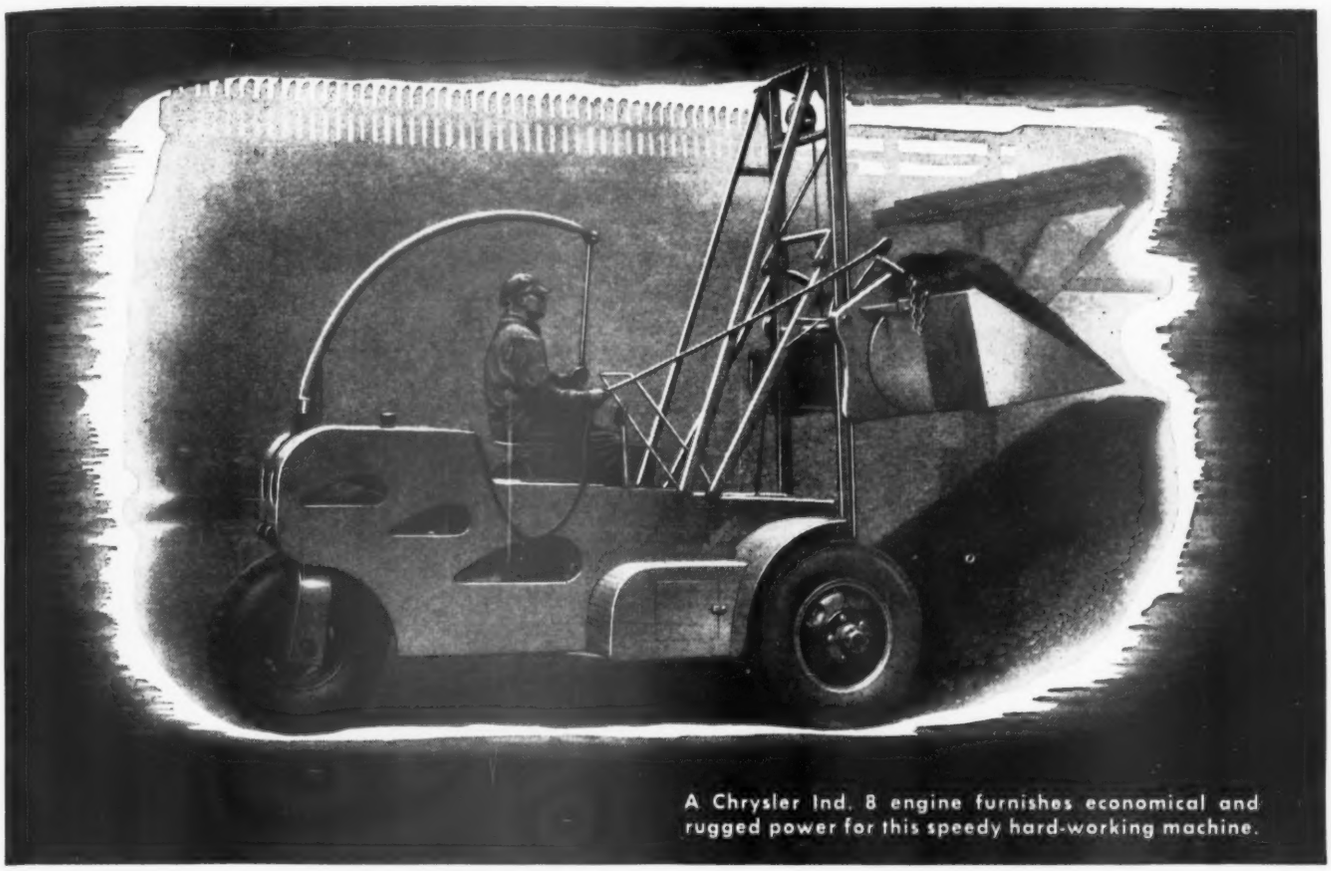

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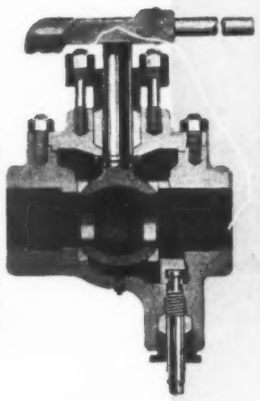
HUB END GATE VALVE
(Fig. — 0431)

. . . 175 lbs. cold water working pressure — non-shock. A non-rising stem gate valve designed for use with Indicator Posts on lines below ground or floor level. Body of semi-steel with high tensile strength, reinforced at all points of strain. Stem of heavy bronze with Acme threads for additional lifting strength and ease of operation. All parts in contact with stem are bronze or bronze lined to prevent corrosion, reduce friction. Sizes 4" through 14".

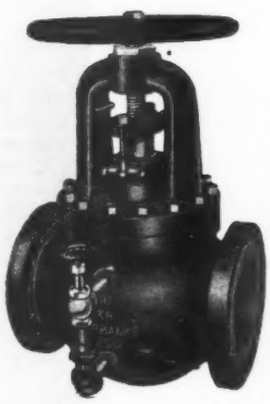
IMPROVED "SPHERO" BALL VALVES
(Fig. — 0850)

. . . 250 lbs. steam working pressure; 500 lbs. cold water, oil or gas pressure — non-shock. A quick opening valve with full flow. ¼ turn fully controls valve. Eliminates all easily corroded, threaded parts in line of flow . . . offers less resistance to flow. Cleaning of working parts can be accomplished without removing valve from line. Sizes ½" through 8".



ASBESTOS PACKED COCK
(Fig. — 0805)

. . . 125 lbs. steam working pressure; 200 lbs. cold water, oil or gas pressure — non-shock. Grooved, asbestos packed plug cock for boiler blow-off service or controlling the flow of certain acids. Body plug and gland are semi-steel with great strength. Plug is barffed (protected against rust by a special process). Asbestos groove packing is vulcanized . . . provides a smooth, non-galling bearing for the plug. Sizes ⅛" through 6".



GLOBE VALVE
(Fig. — 0110)

. . . 250 lbs. steam working pressure; 500 lbs. cold water, oil or gas pressure — non-shock. Extremely rugged iron body, bronze mounted globe valve of the regrinding type. Has ample safety factor to withstand the stresses and strains of high pressure. Bronze stems with Acme threads are of generous proportions for strength and ease of operation. Without removing valve from line, seat and disc may be reground when necessary. Sizes 2" through 12".

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(Fig. — 0405)

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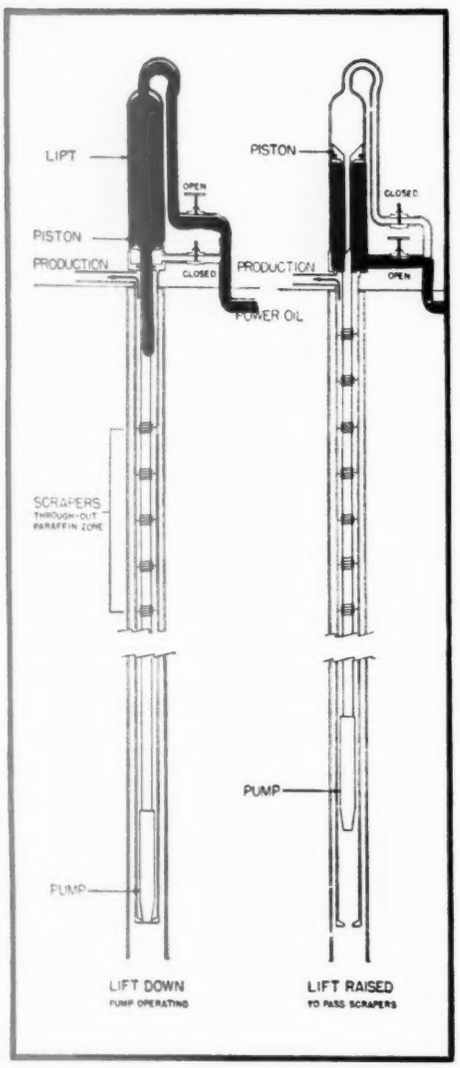

NEW HYDRAULIC LIFT Provides a Quick Inexpensive Means of Disposing of Wax

A new easy-to-operate method of controlling paraffin in pumping wells, that greatly reduces pumping costs, where wax is a production problem, is the latest contribution of *Fluid Power*. It consists of a lift that makes use of the hydraulic power on the lease to raise and lower a series of scrapers positioned in the production tubing.

The lift does away with the need for extra equipment and extra manpower previously required, and eliminates costly down-time.

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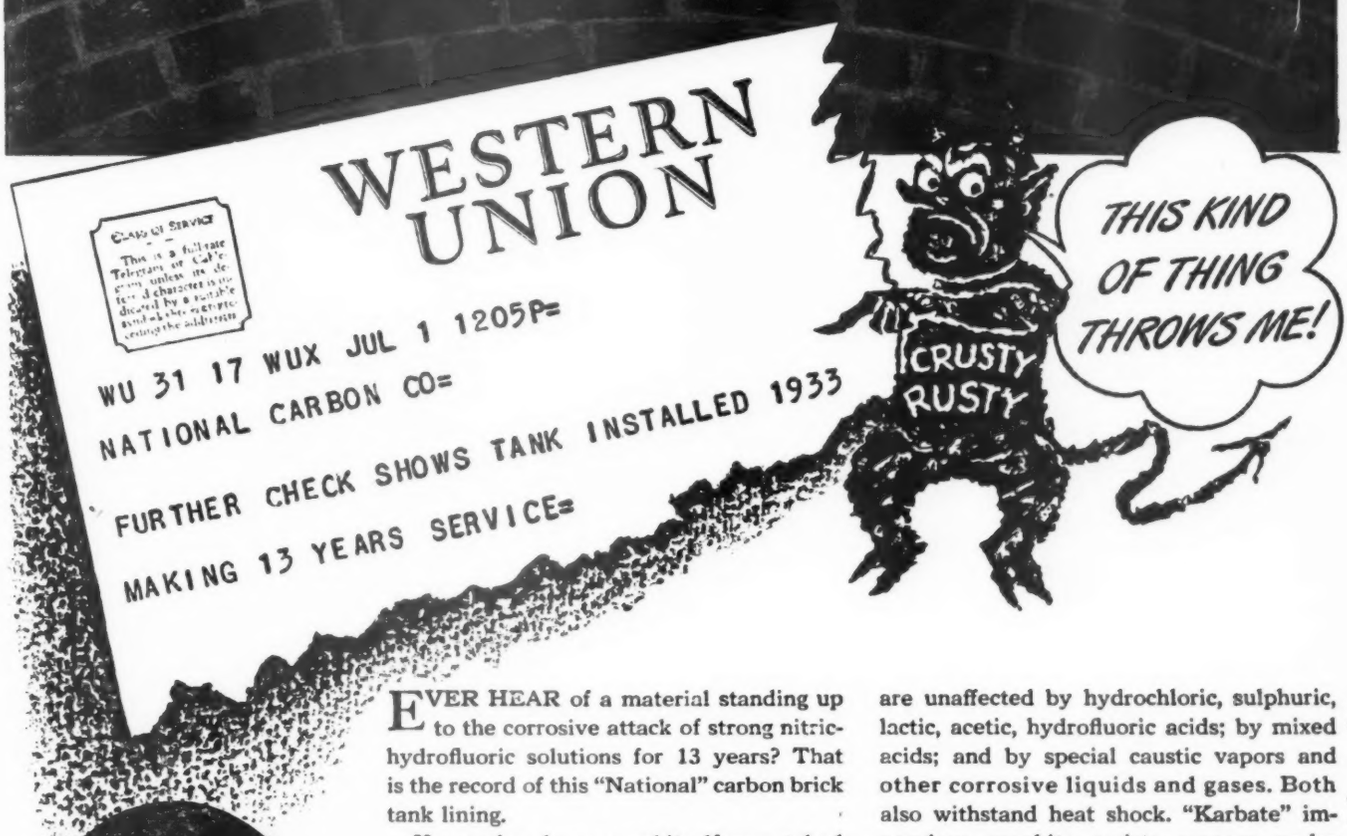
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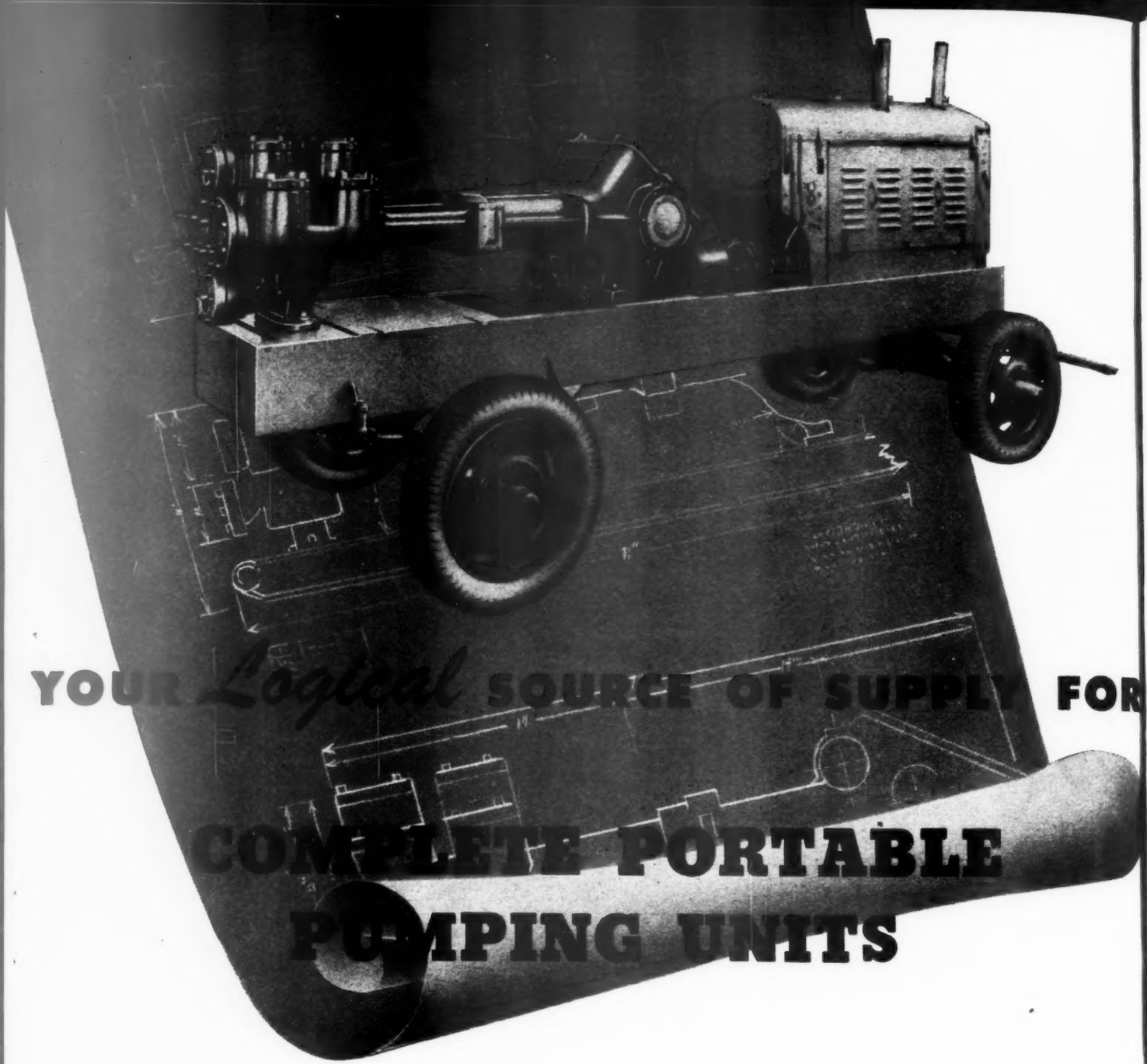

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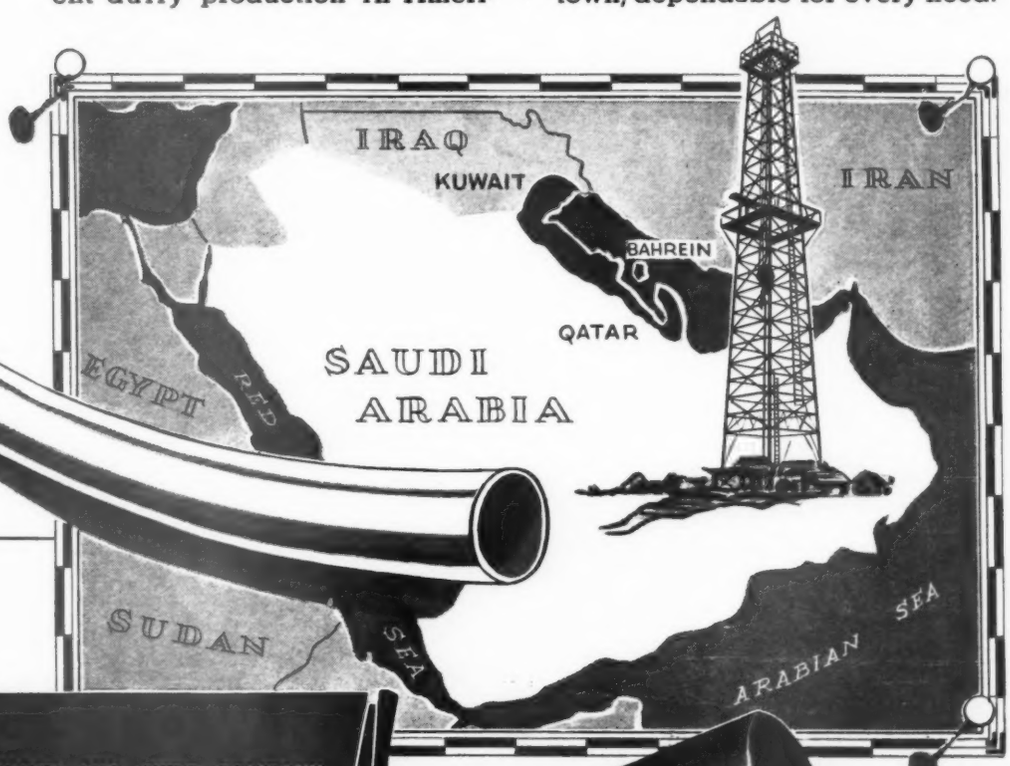

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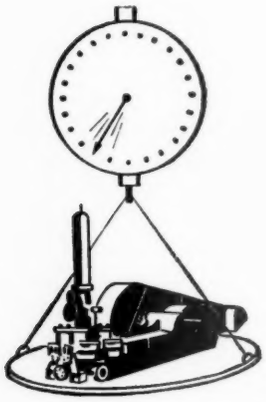

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- ★ *Cast steel connecting rods with special "high lead bronze" liners for crank ends, bronze bushings for crosshead ends.*
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Denver • Continental Supply Co., Continental Bldg., Dallas, Texas
• Republic Supply Company (of California), 2122 E. 7th St., Los Angeles, California.

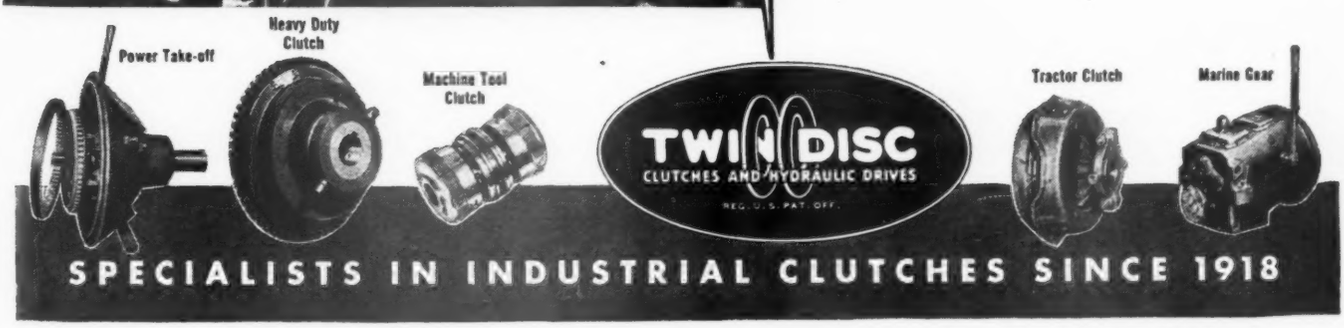
Built to withstand high temperatures

The frictional heat that generates rapidly when a clutch is engaged, particularly under heavy shock loads, can cost you time and money in "down time" unless the clutch is built to absorb the punishment heat is certain to give it.

In the Twin Disc Model P Air-actuated Clutch, you get all the advantages of air operation, plus ample protection against deterioration caused by heat. The large friction areas dissipate heat rapidly, and the materials used have high heat-resisting qualities. The air seals, made of woven asbestos, are located in a position remote from the source of high temperatures, and safely resist these temperatures which result from heavy-duty service.

For complete details, write for Bulletin No. 139. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

The Twin Disc Model P-324 Air-actuated High Speed Drum Clutch provides flexibility and speed—plus ample protection against high operating temperature—in this Emsco G-500 drawworks.



SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

No "Weak Sisters" in this string of casing-

A STAB, a spin, a few hits with the tongs and you have another tight joint with National Seamless Casing.

It's National Seamless 100%

RECENTLY an 8,434 foot string of NATIONAL Seamless 9-⅝" OD Casing was run in a deep-test well in Dewey County, Oklahoma. Field engineers of National Tube Company were invited to witness the event.

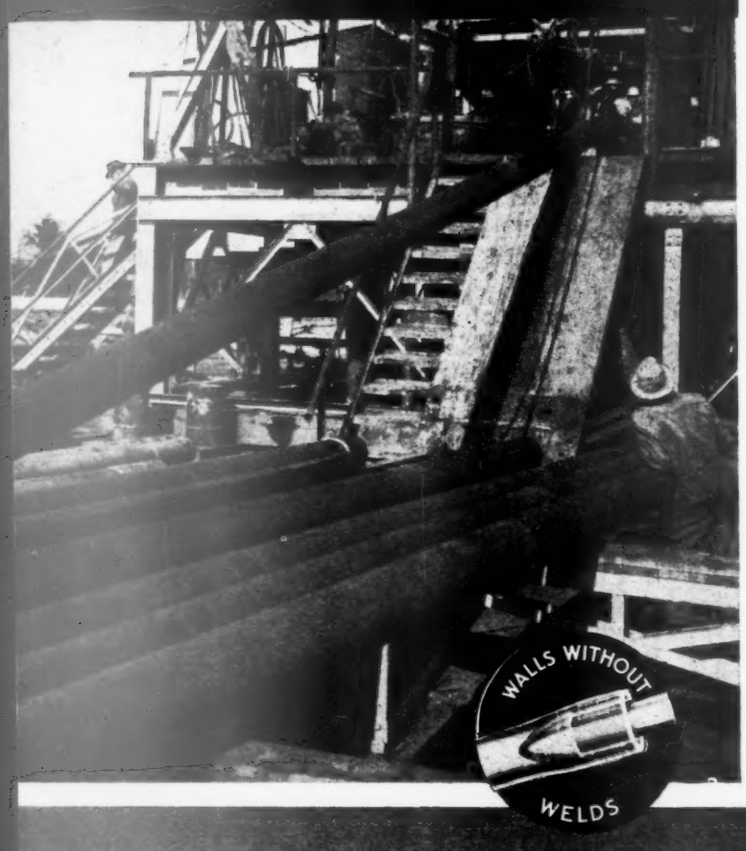
One after another, the sections of casing were quickly spun in. Minimum power make-up buried the threads in every instance except one, where a single thread was left exposed; after another wrap on the cathead, indications showed tight make-up on this joint.

This job is cited not as any kind of a record, but because it represents a good average experience with NATIONAL Seamless Casing which you can expect day after day, string after string. No records were involved, no special selection of casing was made, but each joint went together smoothly, without trouble.

When eight thousand feet of casing make up like this, it indicates the consistent quality of the steel and high degree of accuracy with which the threads are cut. That's why you get faster stabbing, faster running time, and greater assurance of leakproof joints when you use NATIONAL Seamless.

NATIONAL Seamless Casing, Drill Pipe, and Tubing are pierced from solid billets of finest quality steel. There is no longitudinal weld—no line of potential weakness. Each tube is a perfectly formed cylinder, with uniform wall strength throughout. When you use NATIONAL Seamless 100% you can be sure there are no "weak sisters" in the string.

NATIONAL TUBE COMPANY
PITTSBURGH, PA.
United States Steel Export Company, New York



U·S·S NATIONAL SEAMLESS
drill pipe... casing... tubing

NATIONAL TUBE COMPANY
USS
STEEL
UNITED STATES STEEL

DEEP TEST of the Oklahoma Natural Gas Company at Oakwood No. 1 Unit Well, a Dewey County wildcat, drilled by Olson Drilling Company. Every joint in the entire 8,434 feet was uniformly tight. The string was run in the following order:

	Casing shoe	1'9"
	Float collars	3'2"
51	joints - 47#	2022'
31	" - 43.5#	1330'3"
80	" - 40#	3261'7"
16	" - 43.5#	687'3"
31	" - 47#	1138'2"
	Total Footage	8434'2"

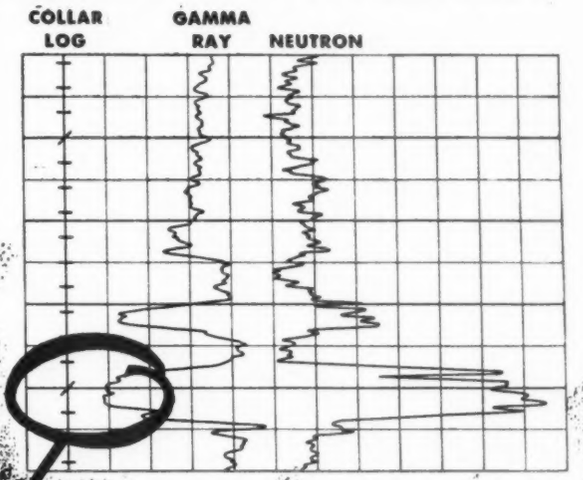
UNITED STATES STEEL

LANE-WELLS SYSTEM OF COLLAR LOCATION

—ELIMINATES MEASUREMENT VARIABLES

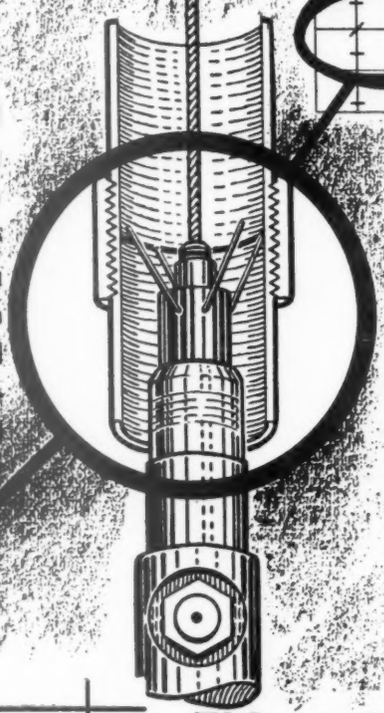
—PERMITS EXACT PERFORATION PLACEMENT

Once casing is set and cemented the relationship between collars and formation is fixed. The collars become accurate bench marks for all subsequent well operations. By means of two simple steps—one electrical and the other mechanical—Lane-Wells uses this fixed relationship to assure accurate placement of gun perforations.



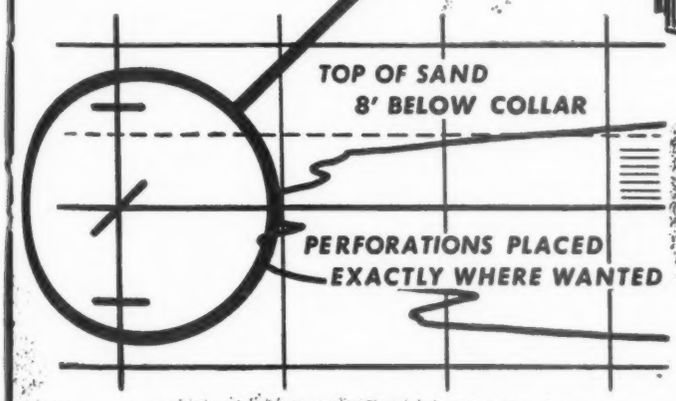
Step #1

The location of collars is recorded electrically with Radioactivity Logging equipment, and each collar is shown on the Log in its fixed relationship to the formation curve. The Collar Log is not charged for when run with a Radioactivity Well Log, but is furnished as an additional feature to provide Oil Well Operators with more useful information about their wells.



Step #2

The reference collar nearest the shooting zone is picked up by the mechanical Collar Locator on the Gun Perforator. This permits accurate perforating even in the thinnest sands without references to bottom or to artificially placed formation markers.



This extreme accuracy saves you time and trouble in...

TESTING OPERATIONS
PLUGBACK OPERATIONS
SQUEEZE CEMENTING
ACIDIZING

"Call Lane-Wells and have the job done right"

Tomorrow's Tools—Today!

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24-HOUR SERVICE 38 BRANCHES

NEED STEEL?

Here's the way to get it

Scrap is needed to produce new steel. Millions of tons of steel products that have served their usefulness are idle —obsolete machines, structural shapes, pipe, old boilers and dozens of other awkward pieces.

Flame-cutting is a fast and economical way to reduce steel to pieces of the right size for charging into furnaces for the production of new steel. Line up a scrapping program *now*—we will be glad to help. Just call the nearest Linde office.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

Special Sale of U.S. SHIPBOARD CABLE for Use in

MINES, OIL WELLS, RAILWAYS, QUARRIES, CONSTRUCTION WORK, ETC.

Whenever rugged electrical cable of single or multiple conductor type is needed and Board of Underwriters' Approval is not a requirement this cable is ideal. It was built to rigid specifications by well known makers to meet the special performance requirements demanded for Navy and Maritime service during the war. This cable is available in large quantity at prices established to move the material into industry's hands quickly. Simply call your nearest W.A.A. office—or send for the special listing described below.

Also LARGE QUANTITIES of AIRCRAFT CABLE ANJC

This cable was manufactured to rigid specifications of both the Army and Navy to meet performance needs with minimum weight and was largely used in aircraft.

FOR SPECIFICATIONS

GET THIS SPECIAL LISTING

Write, wire or phone any W.A.A. office and ask for this special offering of surplus United States Navy and Maritime Shipboard Cable.

EXPORTERS:

Most surplus property is available to the export market. Merchandise in short supply is withheld from export, and if such items appear in this advertisement they will be so identified by an asterisk.

All Shipboard Cable is subject to priority regulations. VETERANS OF WORLD WAR II are invited to be certified at the War Assets Administration Certifying Office serving their area and then to purchase the material offered herein.

WAR ASSETS ADMINISTRATION

GOVERNMENT OWNED SURPLUS

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Fort Worth • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock • Los Angeles • Louisville • Minneapolis • Nashville • New Orleans • New York • Oklahoma City • Omaha • Philadelphia • Portland, Ore. • Richmond • St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane

691-1

HAND APPLIED

REED Super Shrink-Grip TOOL JOINTS

NO NEED for gauging, selective fitting or for sending your pipe to the machine shop when you want to apply or replace Super Shrink-Grip Tool Joints. They can be applied or replaced "at the location," and save you time and money.

Then, too, the safety features will give you longer, safer service life.

Next time, specify Reed Super Shrink-Grip Tool Joints for more wells per string. *½" or 3" hard metal bands can be furnished upon request.*

NO GAUGING OR SELECTIVE FITTING IS REQUIRED

APPLICATION OR REPLACEMENT BY HAND . . . . Anywhere

JUST HEAT THE TOOL JOINT . . . ATTACH THE WRENCH . . . AND SCREW IT ON BY HAND

Reed

ROLLER BIT COMPANY

HOUSTON 1, TEXAS, U. S. A.

Memo: To a prospective licensee—

There's something you ought to know about Houdry. We have the men, the "know-how" and the facilities to analyze your individual problems and to find the right answer for you. Operating studies, process engineering, pilot plant evaluations, earnings . . . right down to the payoff in $/barrel of charge. Backed by the broadest experience in the field of catalytic cracking, *all this is readily available to you.*

You're invited to come see our laboratories where over 400 people are ready to serve you; to visit our catalyst manufacturing plants, including the first catalytic cracking catalyst plants—both natural and synthetic—in the world.

You'll find sound engineering advice awaiting you at Houdry . . . accurate laboratory analyses of your charge stocks, technical service on plant operation, plus a wealth of information on catalytic operations . . . because Houdry service begins when you're ready . . . and never ends.

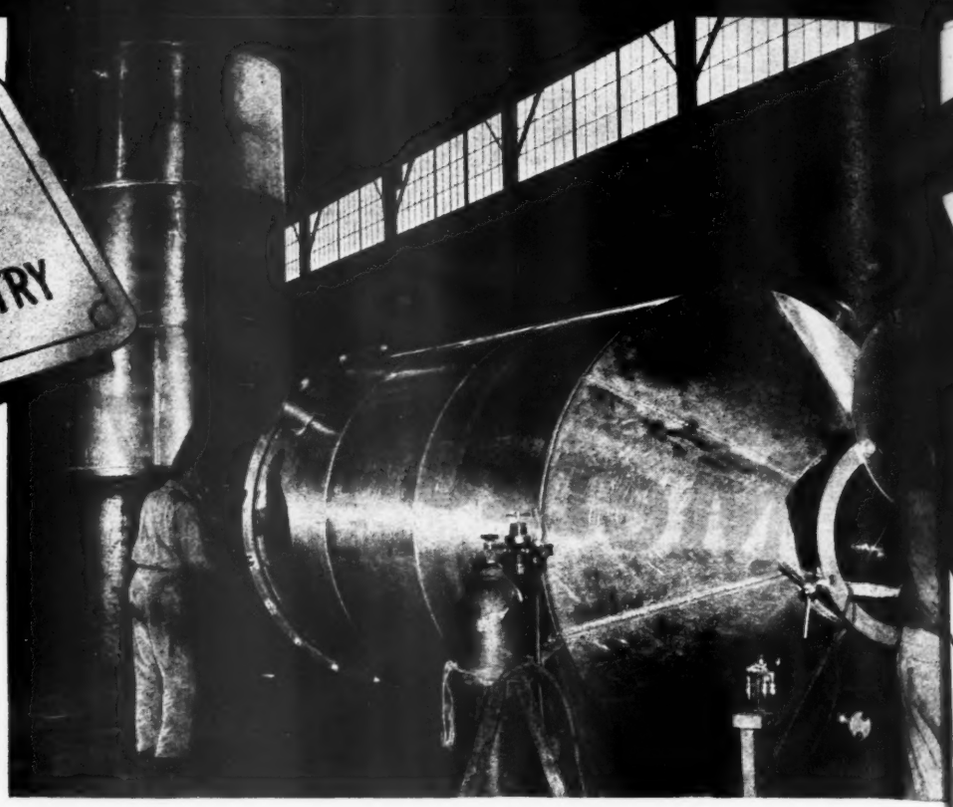
Incidentally, small scale TCC units are now being built for two licensees—and are ready—for all owners of small refineries.

HOUDRY PROCESS CORPORATION

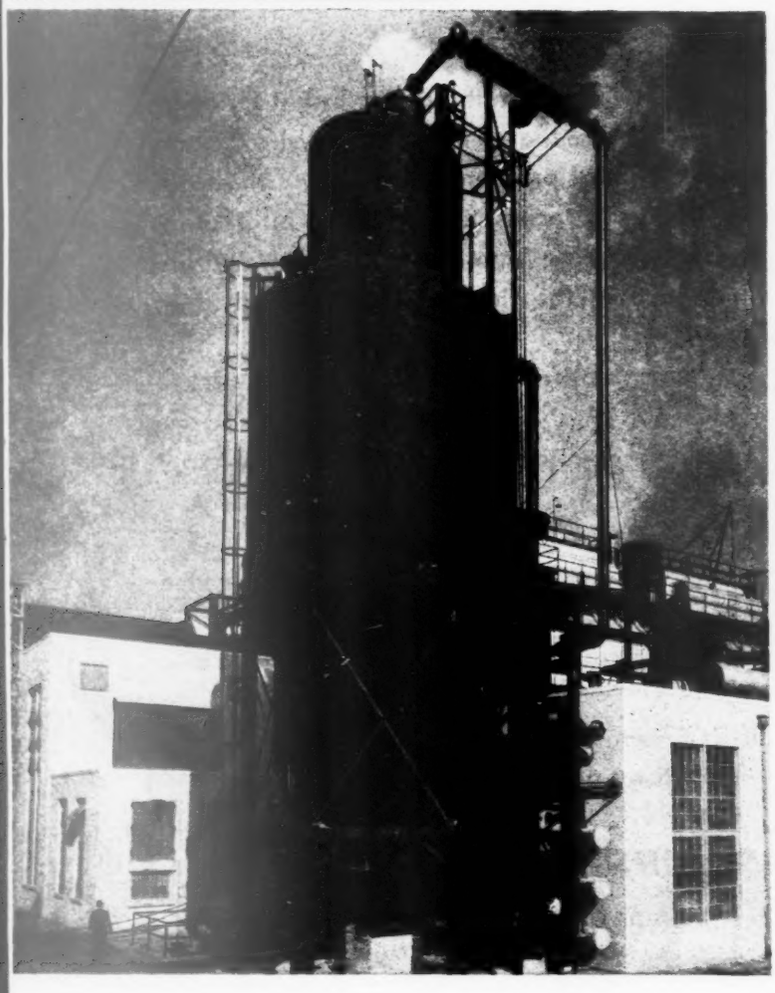
115 Broadway, New York 6, N. Y.

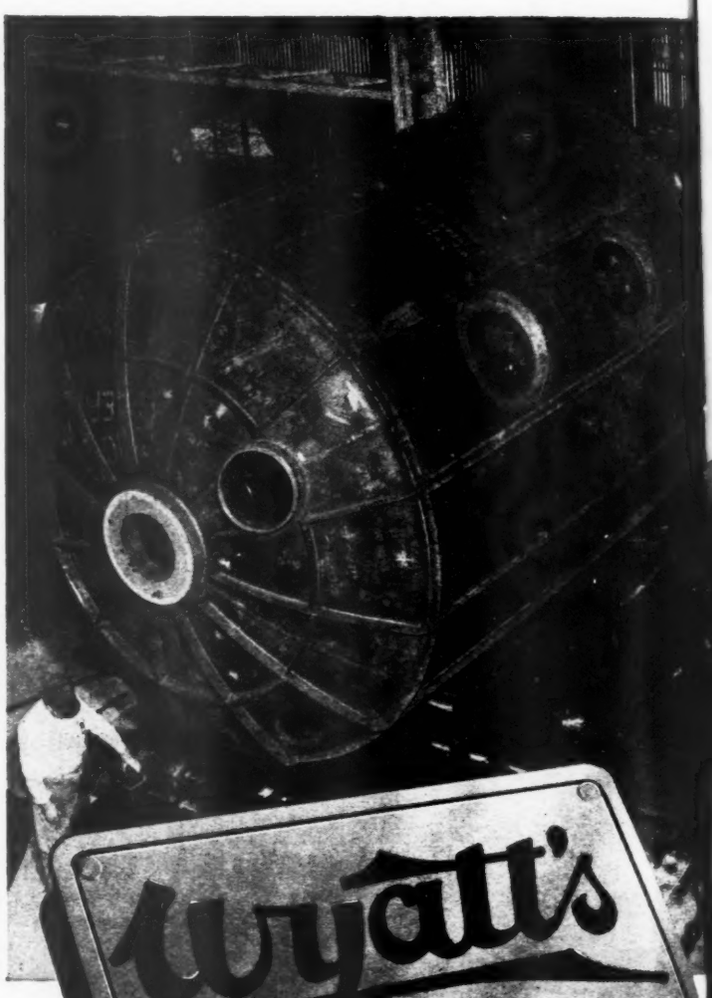
HOUDRY CATALYTIC PROCESSES

SPECIAL STEEL PLATE FABRICATING FOR MODERN INDUSTRY



Above: Aluminum tanks. Left: Buell van Tongeren catalyst collector. Lower left: Water softening equipment. Lower right: Rotating drum for rice processing.





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Steel plate designers, fabricators and erectors to industry's specifications

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When You Install LADISH Controlled Quality FORGED STEEL FITTINGS

Yes, you know they're in to stay when you install Ladish *Forged Steel* Fittings. No more worry about premature failures and consequent crippling shutdowns . . . because Ladish *Forged Steel* Fittings are characterized by the extra strength and toughness that result from advanced *drop forging* procedures.

The rugged, reinforced design combines with a more compact grain structure and accurately controlled grain flow to produce a fitting that resists erosion, shock, strains and stresses common in piping systems.

Ladish Forged Steel Fittings manufactured under painstak metallurgical controls with full curate threads (or deep weld sockets) precision machined for tection against leakage and for of installation. Ladish Fittings un go a rigid inspection for dimensio tolerances, physical soundness metallic composition. Thus each of Ladish Fittings is assured consist *Controlled Quality.*

For the security of economic trouble-free piping installations— stall *Ladish Forged Steel Fittings.*

Sold nationally through Authorized Distributors. Write for your copy of Ladish Forged Steel Fittings Catalog, Vol. II.

Controlled Quality

FITTINGS DIVISION

LADISH DROP FORGE CO.

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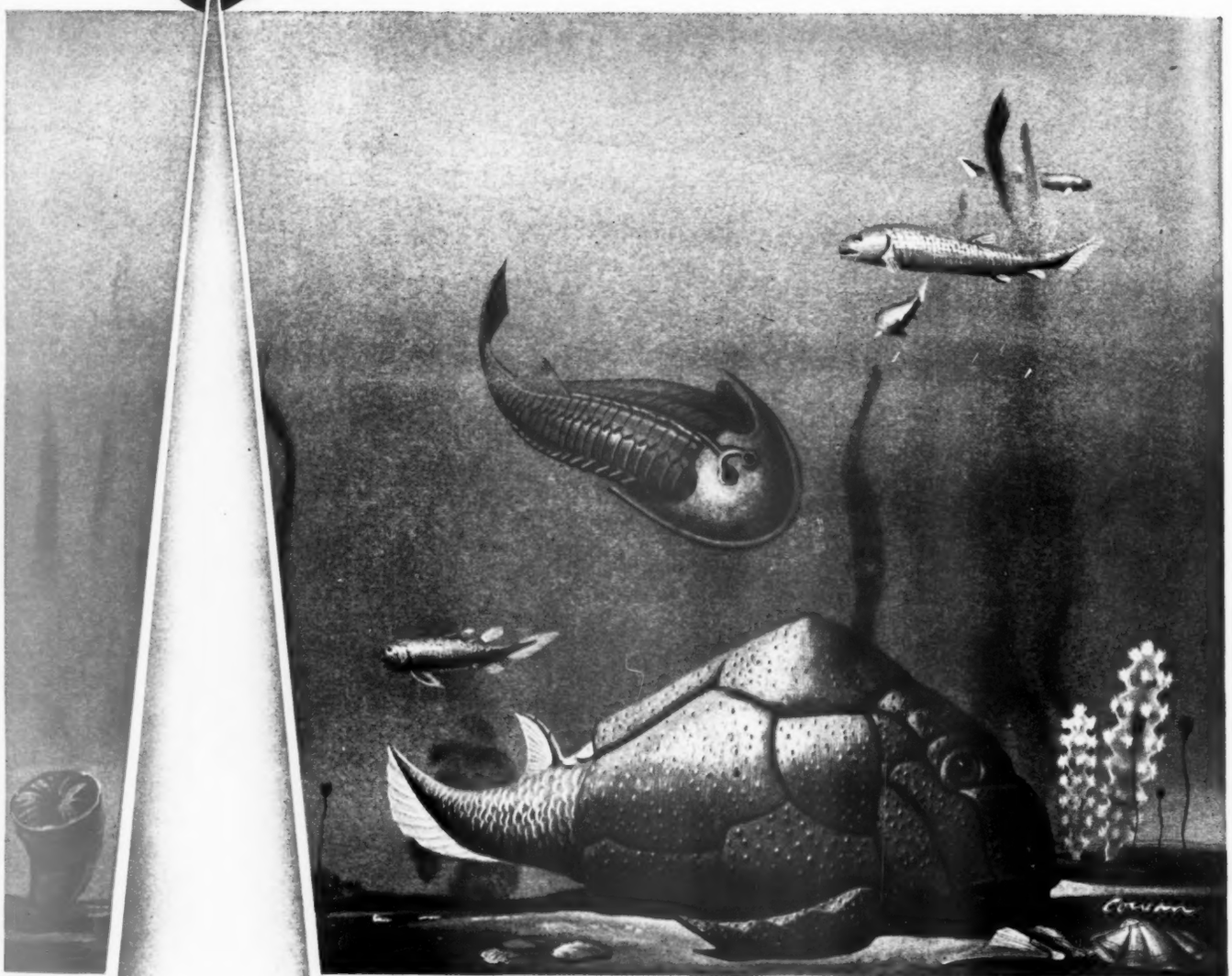
District Offices: NEW YORK • BUFFALO • PITTSBURGH • CLEVELAND • CHICAGO • ST. LOUIS • HOUSTON • NEW ORLEANS • LOS ANGELES

Distinguished by corrosion-resisting Ladish green paint . . . permanent steel identity . . . size and pressure specifications.

hru the Ages with Hughes Rock Bits



Painted for the Hughes Tool Research Division Collection by John Pemberton Cowan

***The* DEVONIAN PERIOD** *was marked by the evolution of animal life from the invertebrate (shell) to the vertebrate (backbone). Shown above* are Devonian Ostracoderms in the foreground and Fishes in the background.*

*Full size color prints of this original painting will be sent upon request.

During the DEVONIAN PERIOD great oil treasures were buried beneath fortifications of waxy-shales, hard lime, sandstone, slate and dolomite for safe-keeping against man's invasion! HUGHES OWS from the family of SUPER-RUGGED ROCK BITS—was developed specifically to penetrate the Devonian strata and similar formations!

That HUGHES OWS ROCK BIT bested the tough resistance of these formations with maximum speed and footage at minimum cost is best evidenced by the fact that this HUGHES SUPER-RUGGED BIT has long since been chosen by three out of four drilling operators!

Hughes TOOL COMPANY
HOUSTON TEXAS

Standard of the Industry

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PRITCHARD builds what YOU want...

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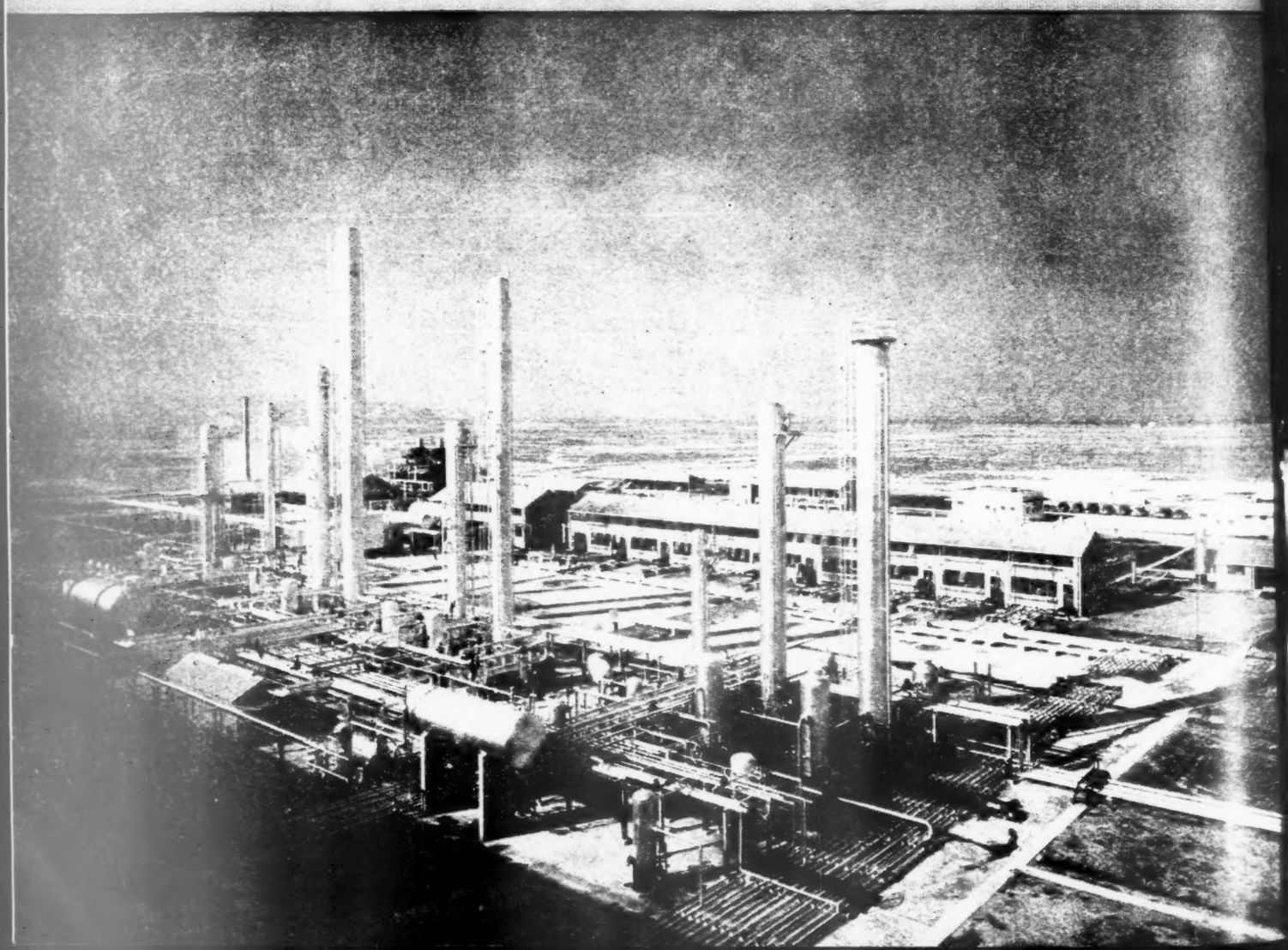
CALIFORNIA'S LARGEST CYCLING PLANT USES Clark Compressors

Photograph on opposite page shows installation of nine Clark 600 BHP compressor units at South Cole's Levee Unit Cycling Plant, Buena Vista Lake, Calif. Below: Exterior view of this modern cycling plant operated by the Ohio Oil Co.



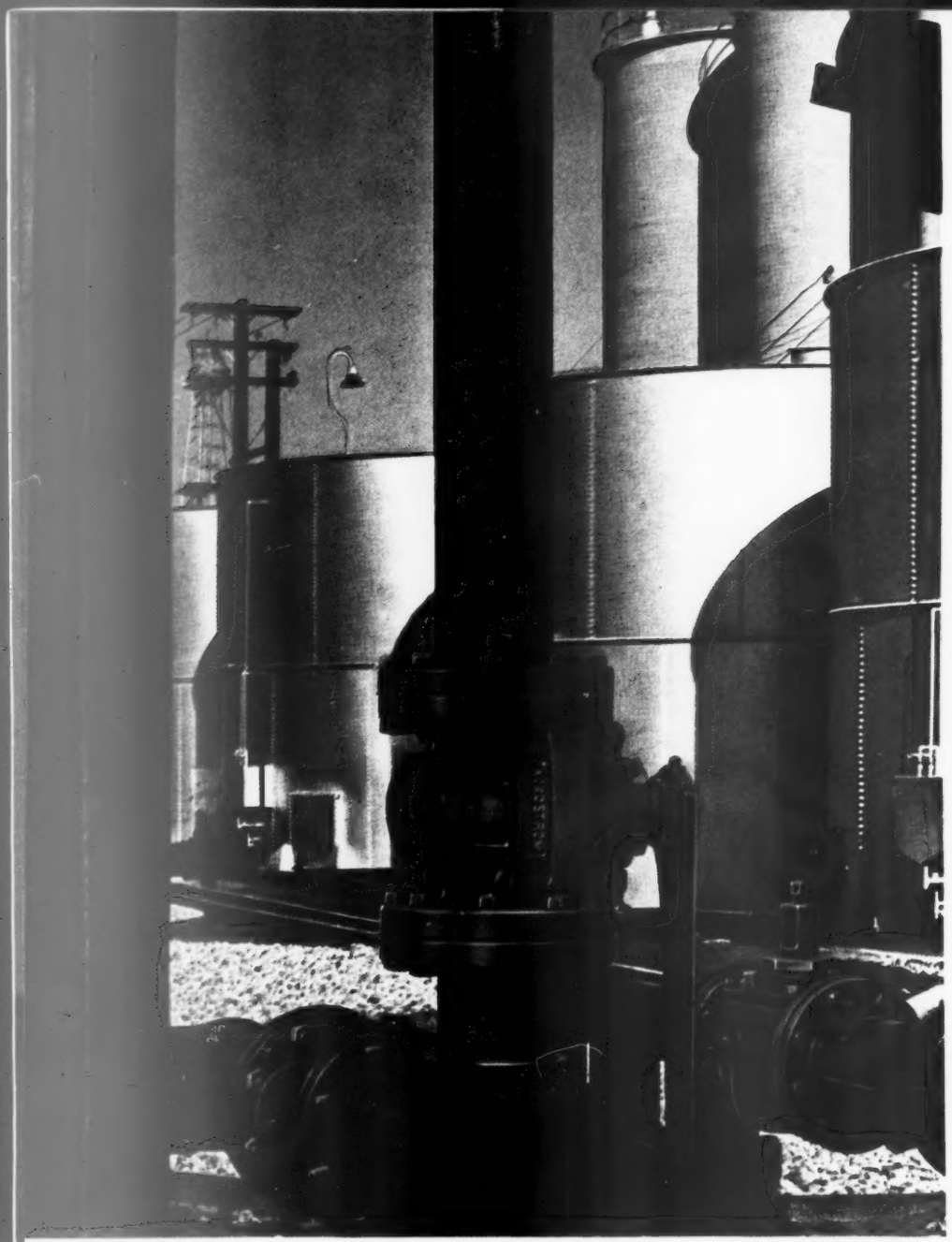
PERFECT CONTROL

with **Safety**

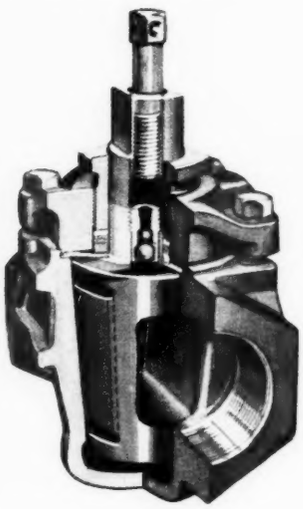
KEEP UPKEEP DOWN

NORDSTROM LUBRICATED VALVES

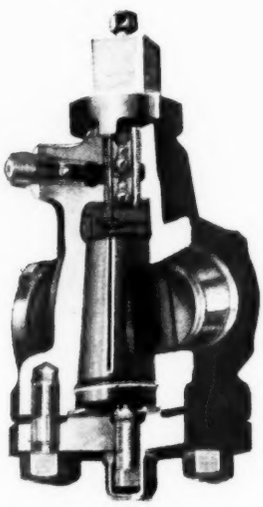
ROCKWELL NORDSTROM



Pennies for LUBRICATION buy years of valve life



STANDARD TYPE



HYPRESEAL TYPE

Metal to metal friction means rapid *wear*. But add lubrication between metal contacts and wear is prevented. Add pressure to the lubricant of a valve plug and another function is provided–*jacking action* to the plug, to insure easy turning. Add the Nordstrom patented "*Sealdport*" principle and still another function is provided –the *positive sealing* of the valve by forming a pressure seal around each port when the valve is closed. This is accomplished by the simple act of pressure lubrication.

Nordstrom LUBRICATED VALVES

Sealdport Lubrication

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WORLD'S LARGEST MANUFACTURERS OF LUBRICATED PLUG VALVES

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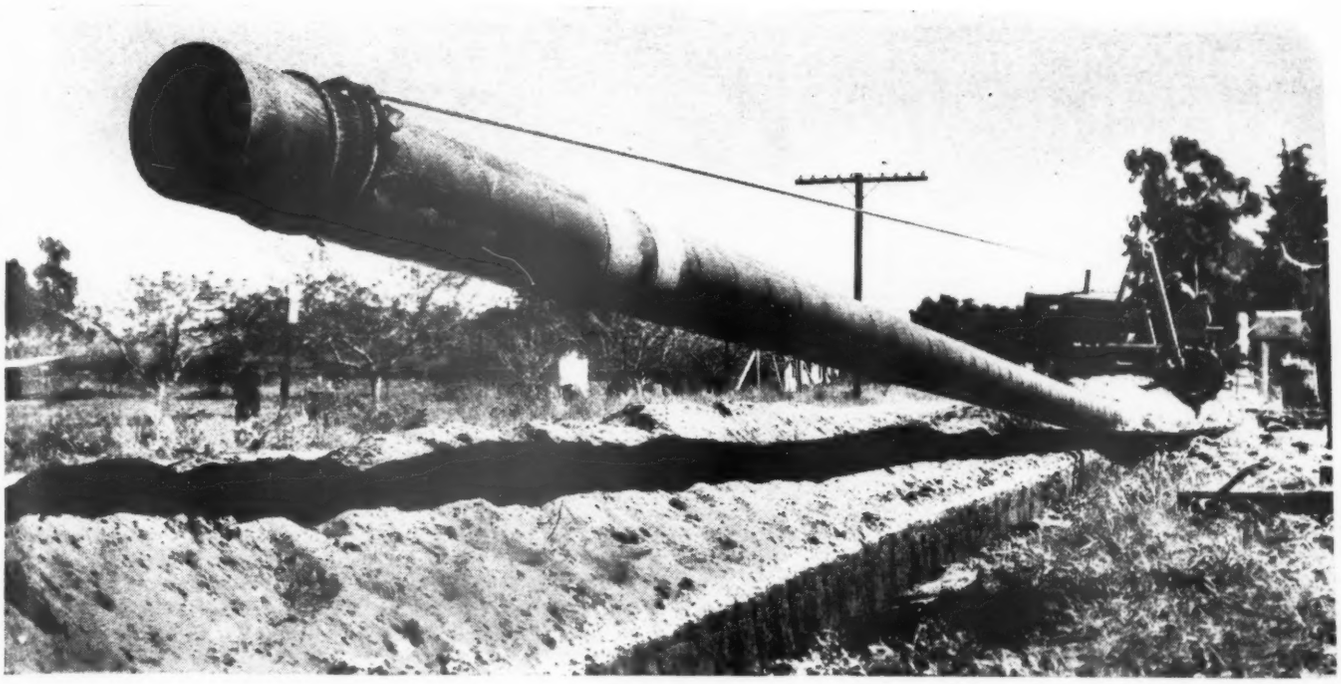
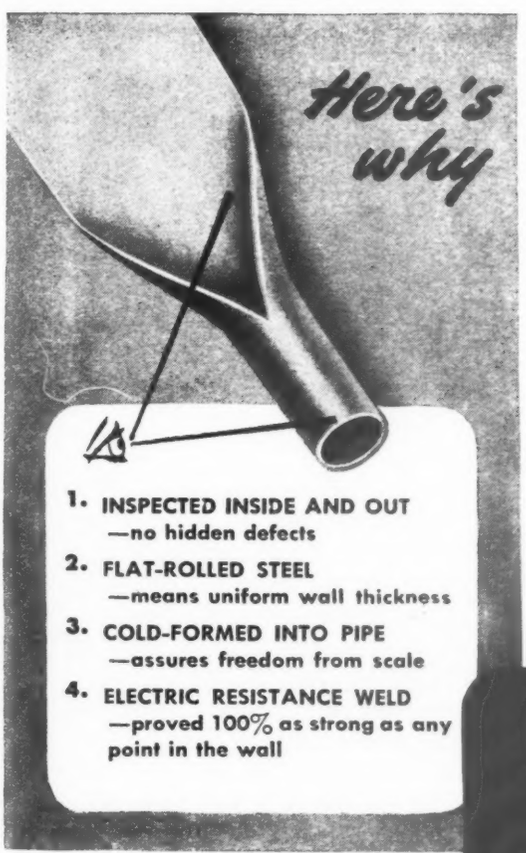


For Pipe Lines with Longer Lifelines

...REPUBLIC ELECTRIC WELD PIPE


Here's why
1. INSPECTED INSIDE AND OUT
—no hidden defects
2. FLAT-ROLLED STEEL
—means uniform wall thickness
3. COLD-FORMED INTO PIPE
—assures freedom from scale
4. ELECTRIC RESISTANCE WELD
—proved 100% as strong as any point in the wall

No matter how long the line, where it is laid or what it carries, every inch of Republic Electric Weld Line Pipe can be depended upon to give long, trouble-free performance.

Actual installation records of more than 40,000 miles of Republic Electric Weld Line Pipe—carrying crudes, gasoline, by-products and natural gas—offer convincing evidence of the long-term economy afforded by this *modern* line pipe.

Yet that's only part of the story. Republic Electric Weld Line Pipe saves countless installation dollars, too. Extra long pipe lengths mean fewer joints . . . consistent uniformity of *diameter, concentricity, straightness* and *ductility* mean faster laying time, fewer man-hours in the field.

Like complete details? Write to:

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
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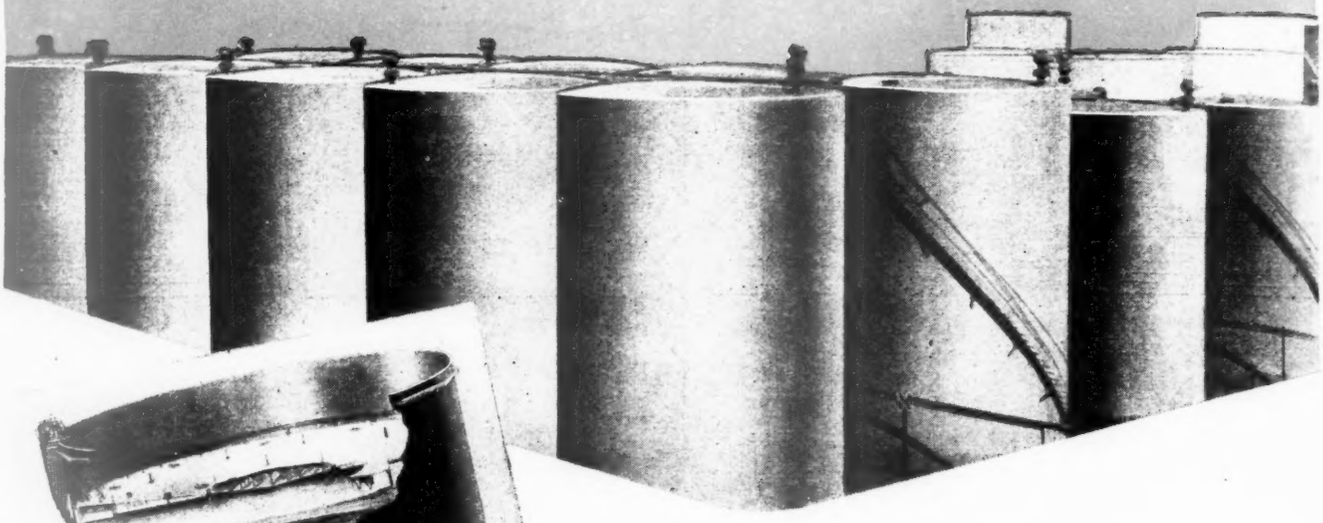
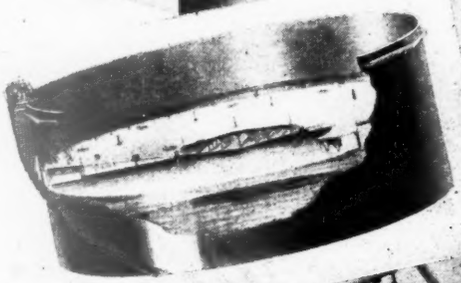
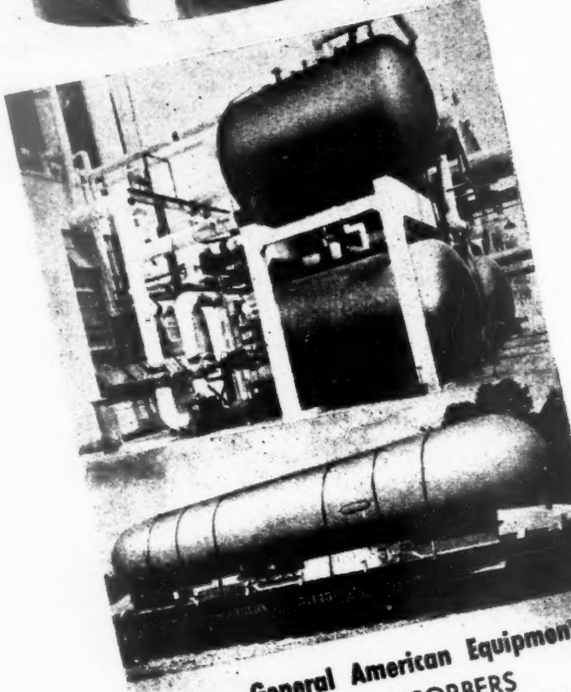
REPUBLIC
LINE PIPE
NORMALIZED CASING AND TUBING

Other Republic Products include Alloy Steels—U

General American Tanks *for* LIQUIDS or GASES







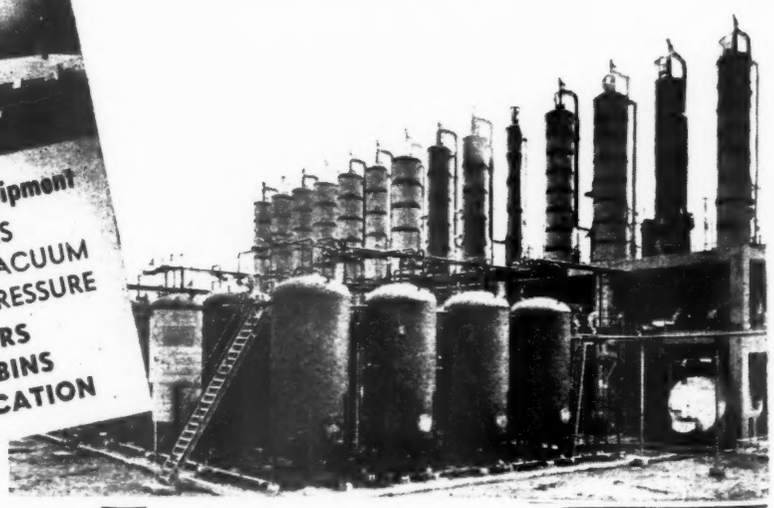
Other General American Equipment

TOWERS: ABSORBERS
BUBBLE • FLASH • VACUUM
FRACTIONATING • PRESSURE
DEWAXING FILTERS
BINS
STACKS
STEEL PLATE FABRICATION

Building tanks for handling liquids or gases has been the business of General American for over 50 years.

As the petroleum chemical industry develops, this organization designs and builds storage tanks specifically for the new materials. Special attention is given to preventing evaporation losses. The General American Hidek Floating Roof, for working tanks with a large throughput or pumping, floats on the liquid surface, eliminating the displacement of vapors that normally occurs in standard type storage tanks.

When a storage problem arises, get in touch with a General American Engineer.



General American
TRANSPORTATION CORPORATION

process equipment • steel and alloy plate fabrication

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Interested in

PORTABLE DRILLING and SERVICING RIGS?

Ask owners about mobile Bucyrus-Erie Spudders!

Their answers will go something like this: "With our Bucyrus-Erie we can rig up in as little as an hour's time" ..."The semi-trailer mounting on my 36-L lets me travel thirty miles an hour, and faster, over regular highways" ..."We make a complete tear-down, move, and new set up in only a few hours."

And if you ask them what else Bucyrus-Erie spudders will do, they'll tell you that these modern big-capacity all-steel rigs handle top-to-bottom drilling, tailing-in, swabbing, and servicing operations with the speed that means profit.

Ask for details on the 36-L, 28-L, and 24-L models!

BUCYRUS ERIE

SOUTH MILWAUKEE WISCONSIN

17546

Bucyrus-Erie Spudders are distributed by

IVERSON TOOL CO. . . . . Tulsa, Okla.; Odessa, Tex.; Artesia, N. M.

MURRAY TOOL & SUPPLY CO. OF TEXAS . Pampa, Tex.

BECKWITH MACHINERY CO. . . . Bradford, Pa.

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GREAT NORTHERN TOOL & SUPPLY CO. . . . Billings, Kevin and Cut Bank, Mont.; Casper, Wyo.

GROSS SUPPLY CO. . . . . El Dorado, Kan.

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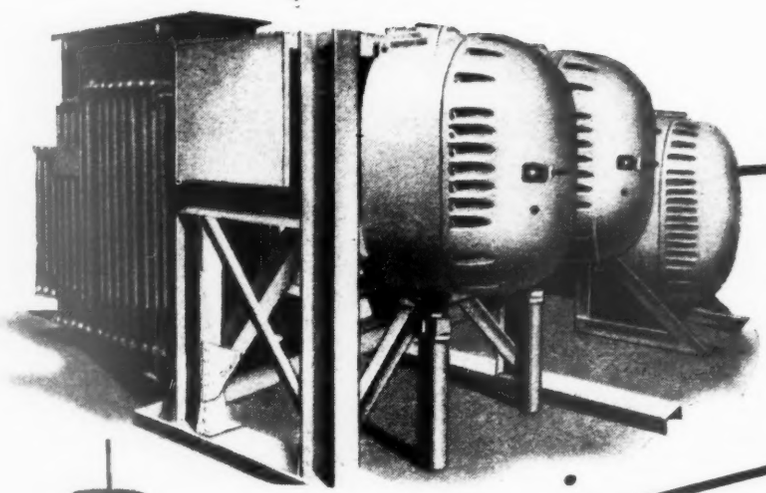
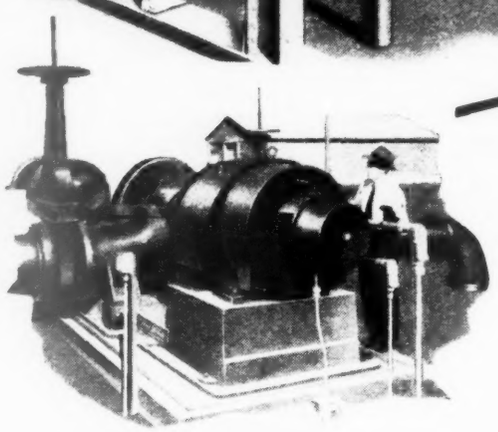
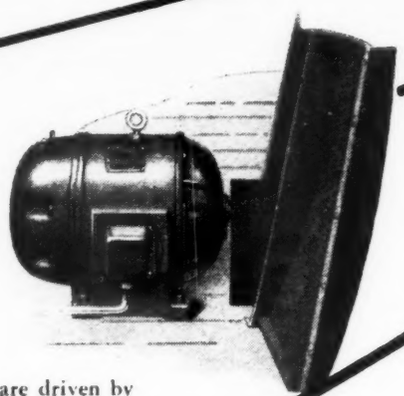
HOW THEY *Stymied* Power Failures



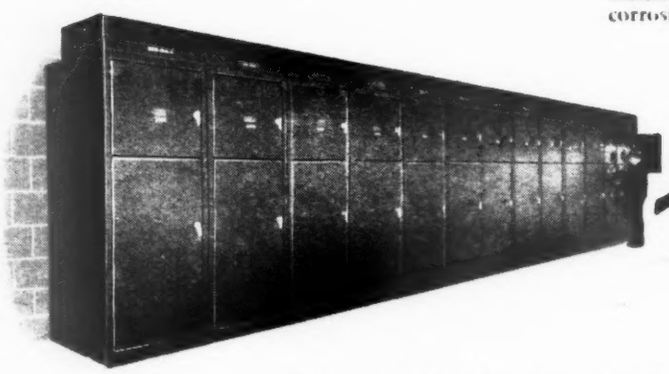
Load-center unit substations equipped with circuit breakers, are located near the Tidewater Avon cracking units. Oil-cooled transformer is shown in the background.



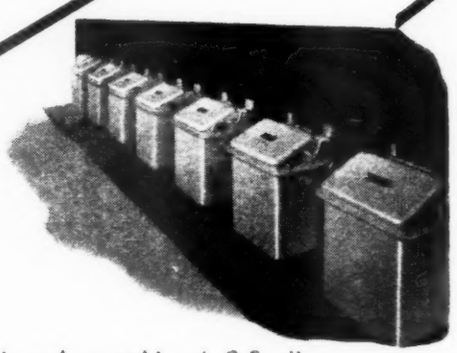
These 450-hp, 900 rpm synchronous circulating pump motors are made with splashproof enclosures, permitting them to be installed outdoors in this mild climate without any special housings.



Cooling tower fans are driven by G-E 50-hp totally enclosed, fan-cooled induction motors. Features include superior insulation and corrosion-resisting paint.



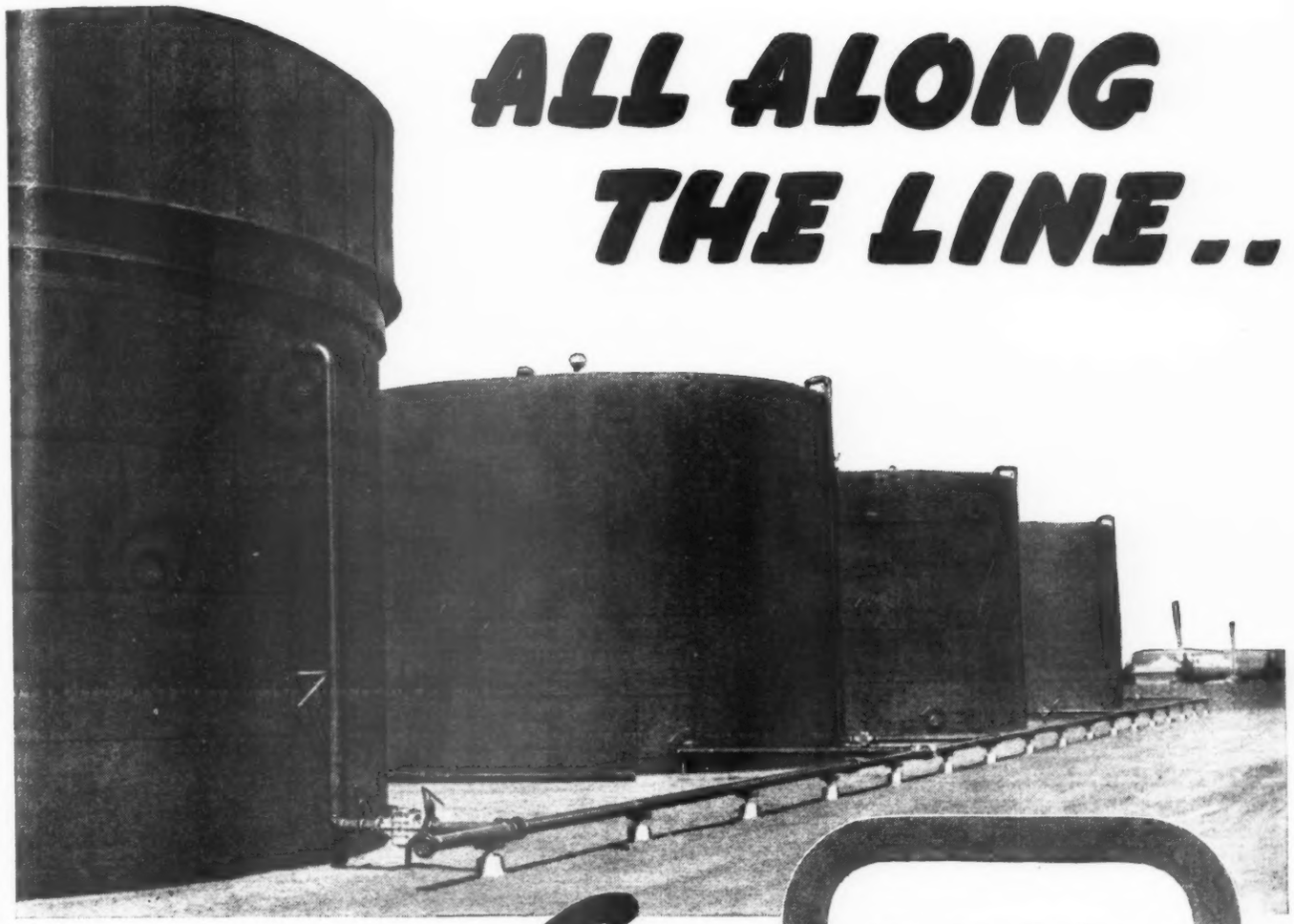
This smooth, dead-front bank of 14 G-E Limitamp combination motor starters is housed in a separate switch house. Contactors are oil-immersed and fuses are housed in individual steel cubicles.



This rack assembly of G-E oil-immersed combination starters controls low-voltage motors. Starters are installed as a complete control group. Maintenance is also simplified.

POWER SYSTEMS *for Refinery Service*

ALL ALONG THE LINE..



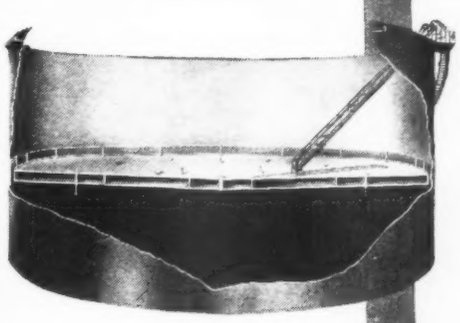
EXPANSION ROOFS SAVE

All along the petroleum supply line, Graver Expansion Roofs are saving storage costs through the elimination of vapor losses.

From production to refining to marketing the Expansion Roof prevents breathing and filling losses in single or multiple tank installations. Through manifolding, as many as eight standard cone roof tanks are protected by a single Expansion Roof tank.

Low maintenance costs, a liquid seal operating efficiently in any climate, no contamination of storage by roof drainage add to the features that mean more savings with the Expansion Roof.

Where other types of petroleum conservation equipment are called for, Graver offers the improved Floating Roof with full double deck construction. It is particularly suited for isolated installations where filling losses are excessive, for water terminals



or for the storage of "sour crudes." Pressure vessels, bullets or spheres, in any size and capacity are also available.

Fabricated Plate Division of

GRAVER

GRAVER TANK & MFG. CO., INC.
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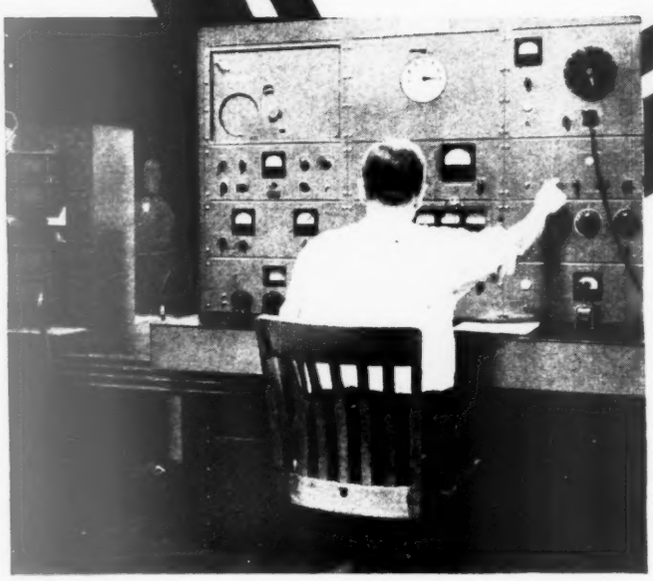
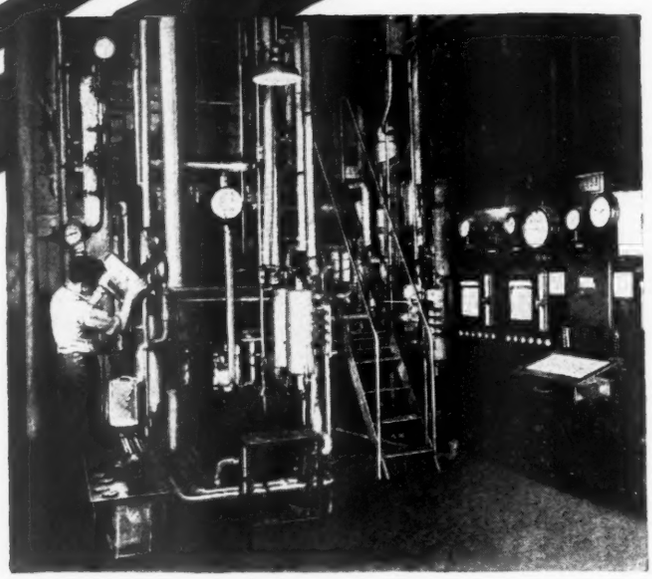
NEW YORK • CATASAUQUA, PA. • CHICAGO • PHILADELPHIA • PORT ARTHUR • PITTSBURGH • SAND SPRINGS, OKLA.

For BEST results we use all nine!



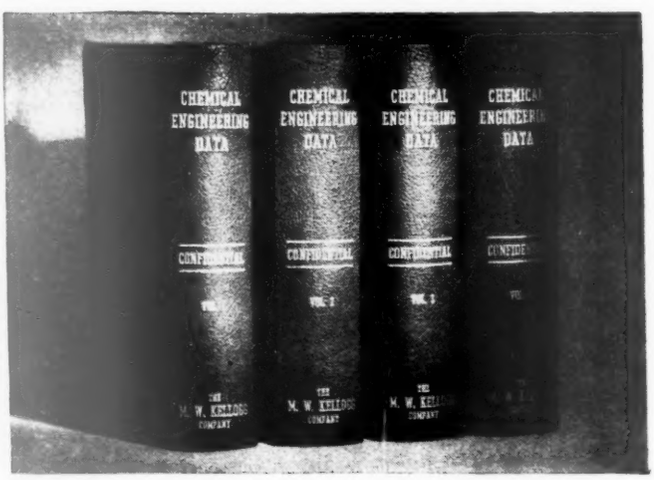
1 LABORATORIES.

Fully equipped, they are staffed by technicians who have made many significant contributions to the science of oil refining, as well as in the field of continuous chemical processing.



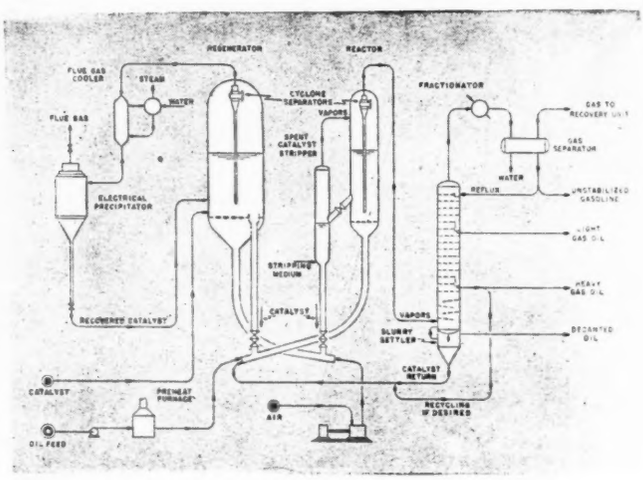
2 24-HOUR-A-DAY PILOT PLANTS.

The most complete pilot plant operation in the oil industry, it includes apparatus to reproduce every major type of refinery process. Operating weight balances so closely approach 100% that results may be converted directly into full-size commercial scale.



3 EXCLUSIVE CHEMICAL ENGINEERING DATA.

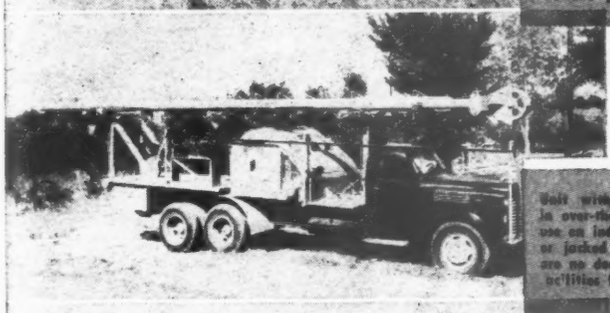
Continuously compiled by a special division of the company, data are derived from Kellogg unit process specialists themselves, from pilot plant operations, from Kellogg built refineries throughout the world, from published literature and from scientific meetings.



4 PROCESS ENGINEERS.

Top-flight, experienced talent has made many outstanding contributions to Fluid catalytic cracking, phenol extraction, naphtha reforming, "Tower" propane deasphalting and other major developments . . . and continues to explore new and more profitable methods of refining.

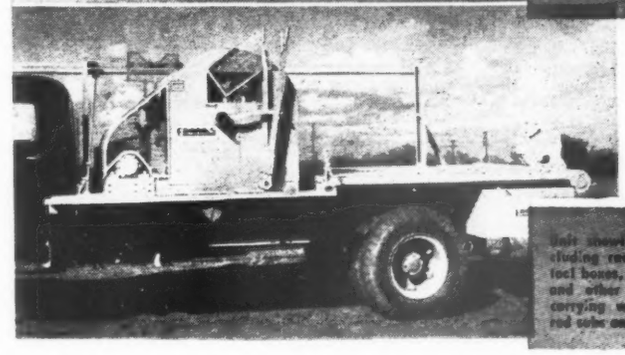
Franks Well Servicing Winch equipped with built-in Telescoping Floor Block (Stinger) in over-the-road position.



Unit with Telescoping Mast in over-the-road position, for use on independently pumped or jacked wells where there are no derricks or permanent facilities for pulling.

Franks Well Servicing Winch showing Rotary Drive Attachment.

Mast sizes to fit any formation from shallow to deep territory. Mast can be raised in position to pull 5 minutes after arriving on location.



Unit showing arrangement, including rack for sucker rods, tool boxes, core sample boxes, and other compartments for carrying well pumps, sucker rod subs and other equipment.

3 in Stock

10 MORE READY FOR DELIVERY IN *Two Weeks*

A recent shipment of trucks enables Franks to offer immediate delivery, subject to prior sale, on 13 self-propelled truck motor-driven single drum well servicing units. Three of these units are now in stock and 10 more will be off the production line and ready for delivery within two weeks.

The photographs, at the left, show the versatility of the unit, which when provided with optional equipment, as conditions require, may be used as conventional winches to pull rods and tubing; for rotary cleanout, and for actual rotary drilling.

The capacities of the models offered range from 2,500 ft. to 8,500 ft. for rod and tubing work.

Wire or phone your needs to the nearest Franks representative or the main office in Tulsa, as these units are available for IMMEDIATE DELIVERY only as long as they last.

FRANKS REPRESENTATIVES

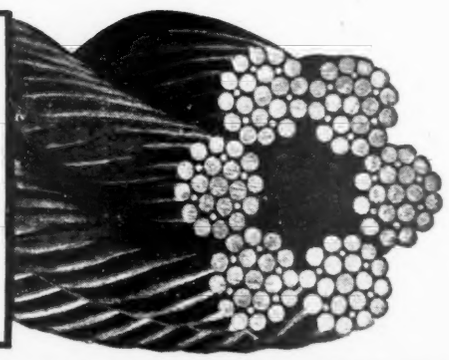
Main Office: Box 3218, Tulsa 8, Oklahoma
Export: A. V. Simonson, 149 Broadway, New York, N. Y.
California: Hillman-Kelley, Inc., 1000 Macy Street, Los Angeles
Illinois Basin: Stuart E. Corry, Box 51, Fairfield, Illinois.
Texas, Louisiana, New Mexico, Arkansas, Mississippi: R. M. White, 823 Neil P. Anderson Bldg., Fort Worth, Texas
Rocky Mountan: Industrial Power Units, Inc., Box 152, Casper, Wyo.

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS

union Wire Rop

"Steel Tendons" is a new book of photographs and descriptions which show you how Union Wire Rope is made, from the laboratory to the master reel.

Nine educational bulletins entitled "Rope Dope" are published at frequent intervals. They contain valuable information for the wire rope user on such subjects as: replacement of wire rope as to size, tread, diameter, type of construction and correct grades of steel; explanation of the lays of wire rope; types of wire ropes with complete specifications; factors which determine rope life; installation and abuses to be avoided; care of wire rope; abuses and their results and figuring the working load and actual stresses.

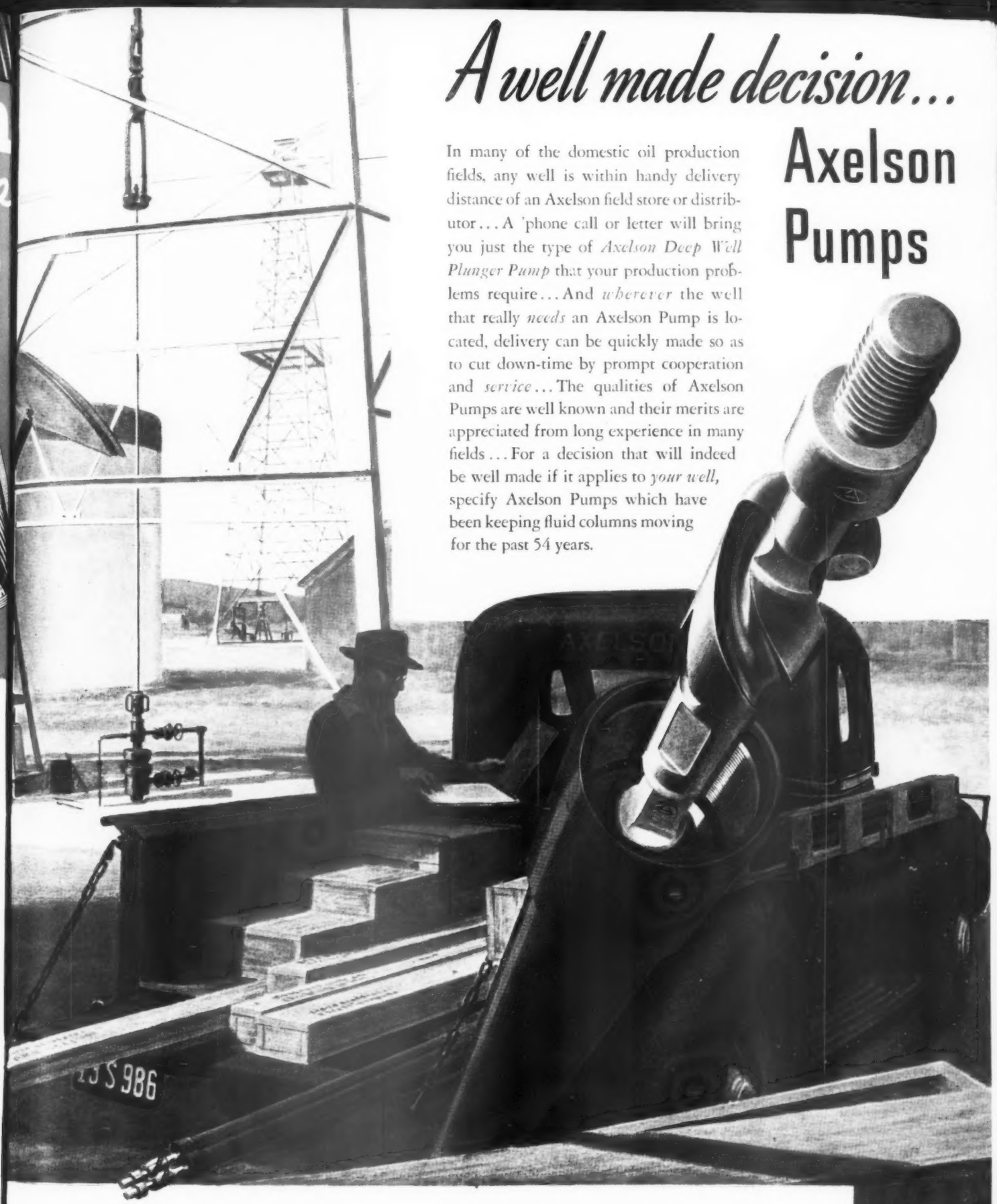


Union-formed wire rope is designed to do specific jobs better—longer and with greater economy. Internal stress and strain are removed by special forming giving Union-formed more flexibility and stamina.

union-formed

(preformed)

THE ULTIMATE IN LOW COST WIRE ROPE



A well made decision...

Axelson Pumps

In many of the domestic oil production fields, any well is within handy delivery distance of an Axelson field store or distributor... A 'phone call or letter will bring you just the type of *Axelson Deep Well Plunger Pump* that your production problems require... And *wherever* the well that really *needs* an Axelson Pump is located, delivery can be quickly made so as to cut down-time by prompt cooperation and *service*... The qualities of Axelson Pumps are well known and their merits are appreciated from long experience in many fields... For a decision that will indeed be well made if it applies to *your well,* specify Axelson Pumps which have been keeping fluid columns moving for the past 54 years.

AXELSON DEEP WELL PLUNGER PUMPS

AXELSON MANUFACTURING COMPANY

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Consult your classified directory for the nearest Axelson dealer in your vicinity, or write, wire or telephone the Axelson Plant at Los Angeles or St. Louis.

MAINTAIN AND SUPPORT FREE ENTERPRISE

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

For Refineries: A Truly Complete Piping Materials Service

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Whatever the piping job calls for—anywhere in the refinery—most likely the best item for the purpose can be secured from Crane.

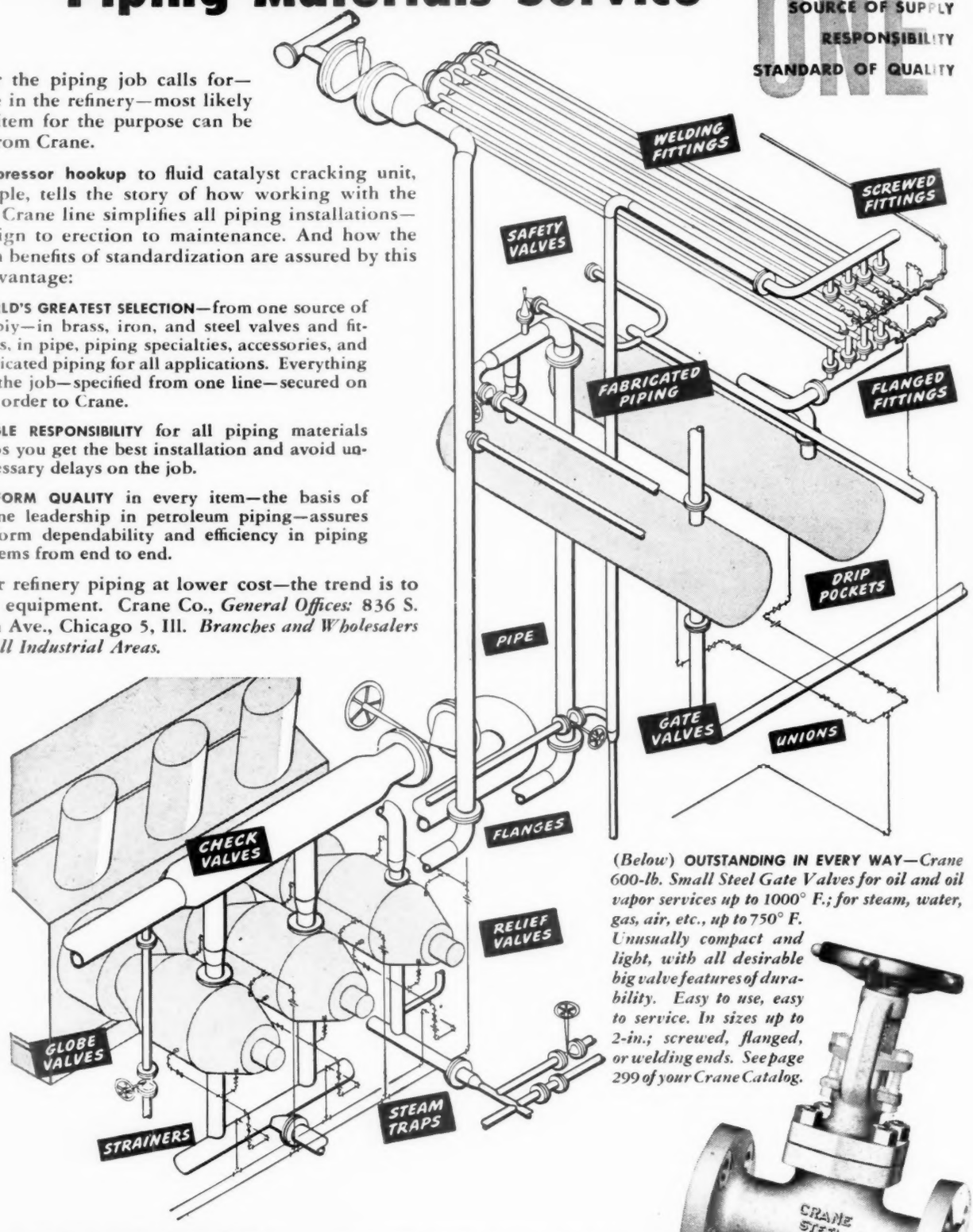
This compressor hookup to fluid catalyst cracking unit, for example, tells the story of how working with the complete Crane line simplifies all piping installations—from design to erection to maintenance. And how the maximum benefits of standardization are assured by this 3-way advantage:

WORLD'S GREATEST SELECTION—from one source of supply—in brass, iron, and steel valves and fittings, in pipe, piping specialties, accessories, and fabricated piping for all applications. Everything for the job—specified from one line—secured on one order to Crane.

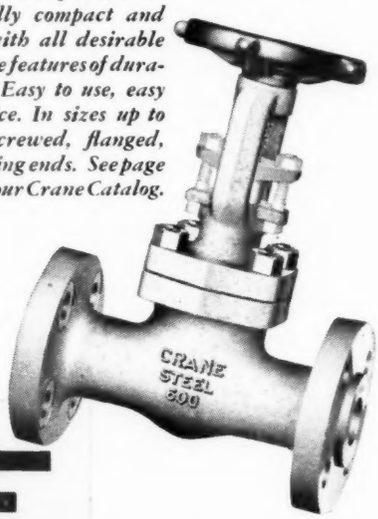
SINGLE RESPONSIBILITY for all piping materials helps you get the best installation and avoid unnecessary delays on the job.

UNIFORM QUALITY in every item—the basis of Crane leadership in petroleum piping—assures uniform dependability and efficiency in piping systems from end to end.

For better refinery piping at lower cost—the trend is to all-Crane equipment. Crane Co., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*



(*Below*) **OUTSTANDING IN EVERY WAY**—*Crane 600-lb. Small Steel Gate Valves for oil and oil vapor services up to 1000° F.; for steam, water, gas, air, etc., up to 750° F. Unusually compact and light, with all desirable big valve features of durability. Easy to use, easy to service. In sizes up to 2-in.; screwed, flanged, or welding ends. See page 299 of your Crane Catalog.*



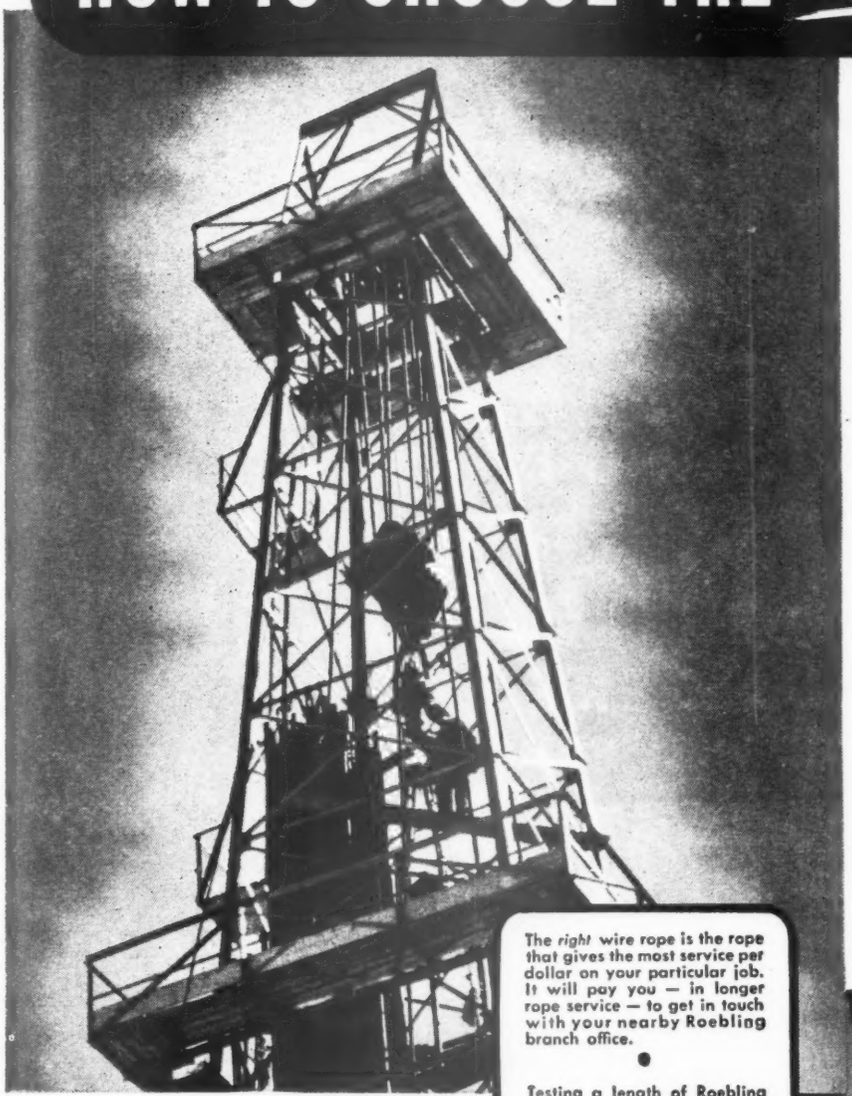
EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
HEATING • PUMPS

CRANE

FOR EVERY PIPING SYSTEM

HOW TO CHOOSE THE *RIGHT* ROPE



. . . and get lowest handling cost!

YOU DON'T ALWAYS have the time to study the often obscure details affecting wire rope service on your installations. But your Roebling Field Engineer is constantly making such studies.

His daily contacts include tracking down the facts on practically every type of wire rope installation. He has specialized knowledge of wire rope usage . . . and of wire rope, too.

After careful study the Roebling Field Engineer can help you choose the *right* rope . . . the one that will give you top service per dollar. Of course, he will recommend Roebling "Blue Center" Steel Wire Rope. For here is a complete line—both preformed and non-preformed — where he can find the wire rope that combines the right balance of strength and flexibility, of fatigue and abrasion resistance.

Call or write our nearest branch office. Get in touch with your Roebling Field Engineer.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

The *right* wire rope is the rope that gives the most service per dollar on your particular job. It will pay you — in longer rope service — to get in touch with your nearby Roebling branch office.

●

Testing a length of Roebling "Blue Center" Steel Wire Rope is important—*to you.* It gives engineering data to your Roebling Field Engineer . . . information that can save your wire rope dollars.

Manufacturers of Wire Rope and Strand • Fittings • Slings • Suspension Bridges and Cables • Aircord, Aircord Terminals and Air Controls • Aerial Wire Rope Systems Electrical Wire and Cable • Ski Lifts • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel • Screen, Hardware and Industrial Wire Cloth • Lawn Mowers

Wire Rope Distributed by:
THE NATIONAL SUPPLY CO.
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PREFORMED • NON-PREFORMED

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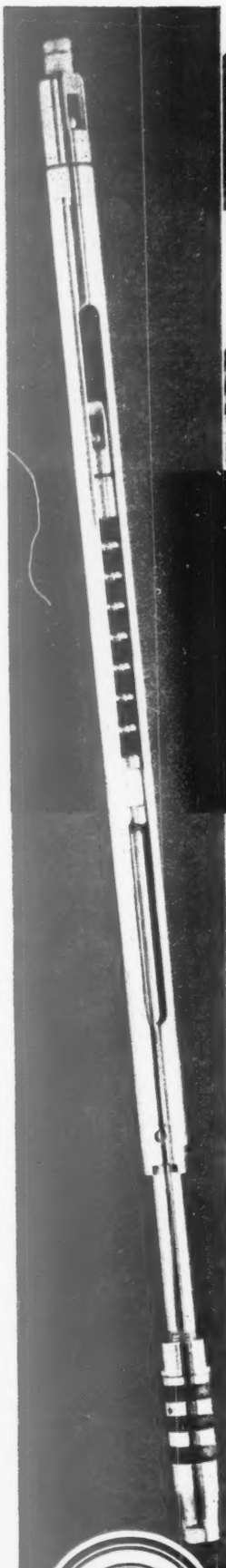
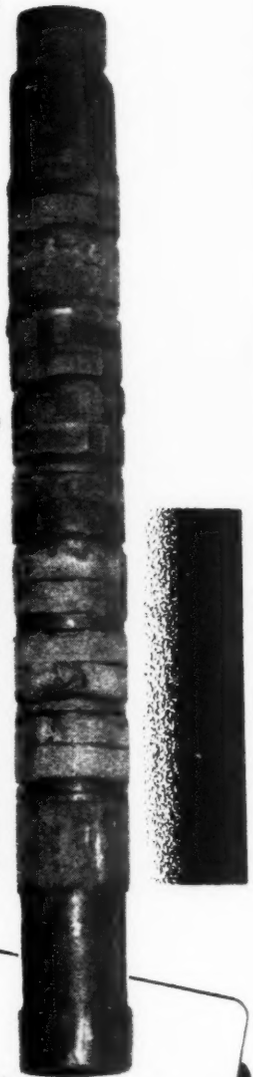
PACEMAKER IN WIRE PRODUCTS

ONE RECUP JOB* in over a year's Continuous Pumping!



The New G-B EXPAN-SEAL PLUNGERS FOR OIL WELL PUMPS



★ **LONGER LIFE**

★ **FEWER PULLING JOBS**

★ **NO GAS-LOCKING**

This new, patented plunger design for insert or common working barrel pumps assures substantial cost reduction of pulling jobs—a greater service expectation wherever installed, regardless of pumping conditions.

Unlike previously known plungers, the G-B EXPAN-SEAL Plunger continuously pumps with an absolute pressure seal even when worn to the point where others have to be removed – because the rings "expand on the lifting stroke under pressure of the load." They automatically contract on downward strokes to eliminate unnecessary wear, to prevent gas-locking and to allow the washing away of any abrasive sand.

It will pay to investigate the G-B EXPAN-SEAL Plunger—the newest, most efficient now on the market.

***CASE HISTORY No. 246**

Unretouched Photo

. . . of a G-B EXPAN-SEAL Plunger after continuous operation of over 1 year. The original cups were replaced after six months service—the present cups had been in operation the balance of the time.

This plunger and present cups were still giving satisfactory service when pulled for observation and analysis.

NOW Available At Your Supply Store

For insert pumps—either traveling plunger or traveling tube – or common working barrels.

Manufactured Exclusively Under Hunter Patents By

G·B MFG. CO. Established 1898

GUSTIN-BACON MANUFACTURING CO.

KANSAS CITY 7, MO.

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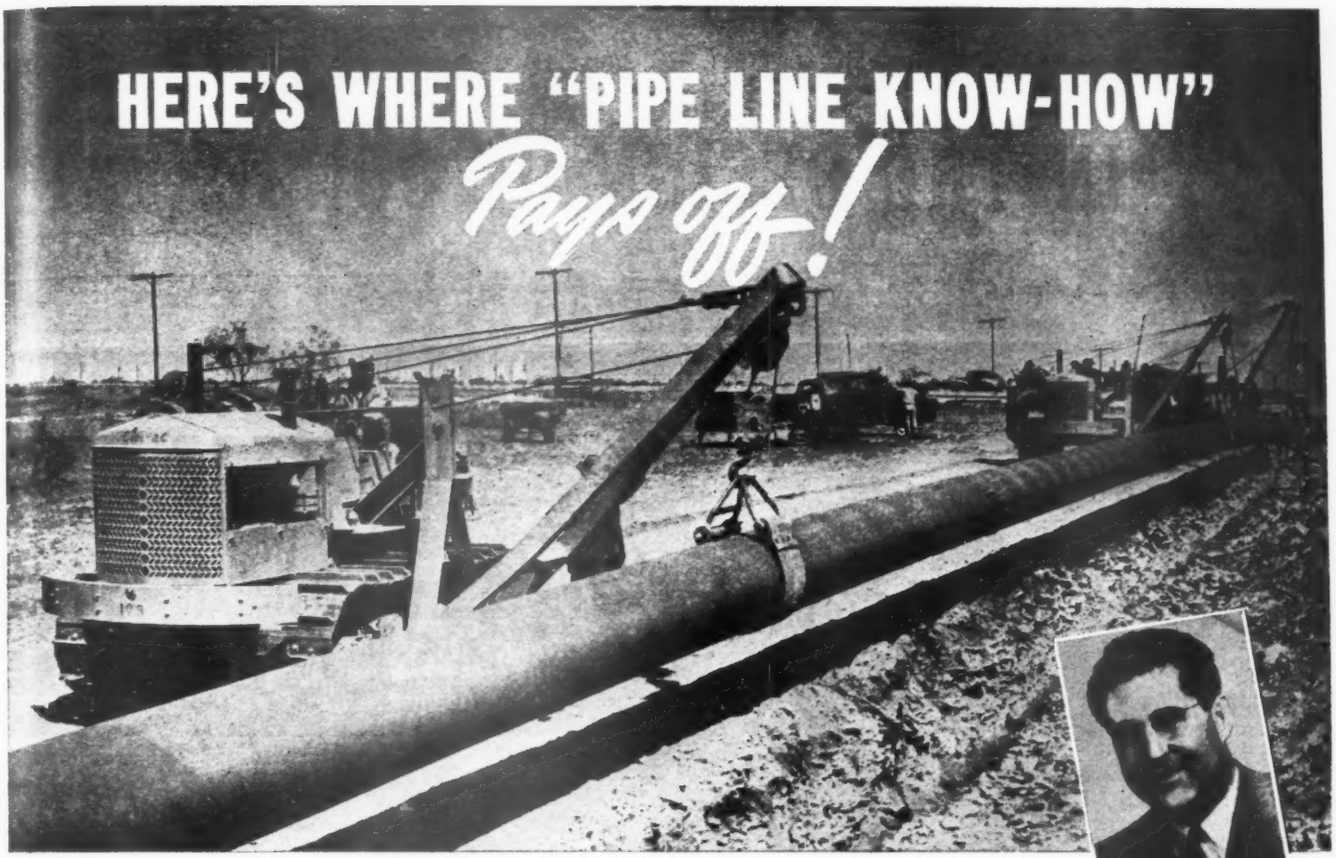
SAN FRANCISCO TULSA FORT WORTH

HERE'S WHERE "PIPE LINE KNOW-HOW" *Pays Off!*



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F. A. SMITH
Partner

J. H. SMITH
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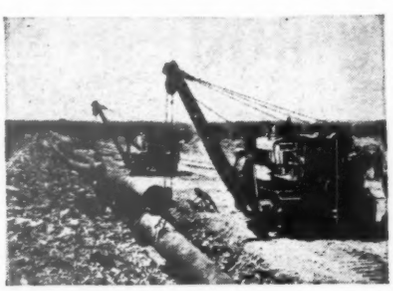
Our "Pipe Line Know-How" paid dividends in setting high standards of speed and efficiency during the construction of the Dallas-Hearne section of the Humble Baytown-to-Dallas 8-inch products line. More proof of this fact—when you want outstanding results in pipe line construction, call in Smith Contracting Company.



PIPE LINE CONSTRUCTION

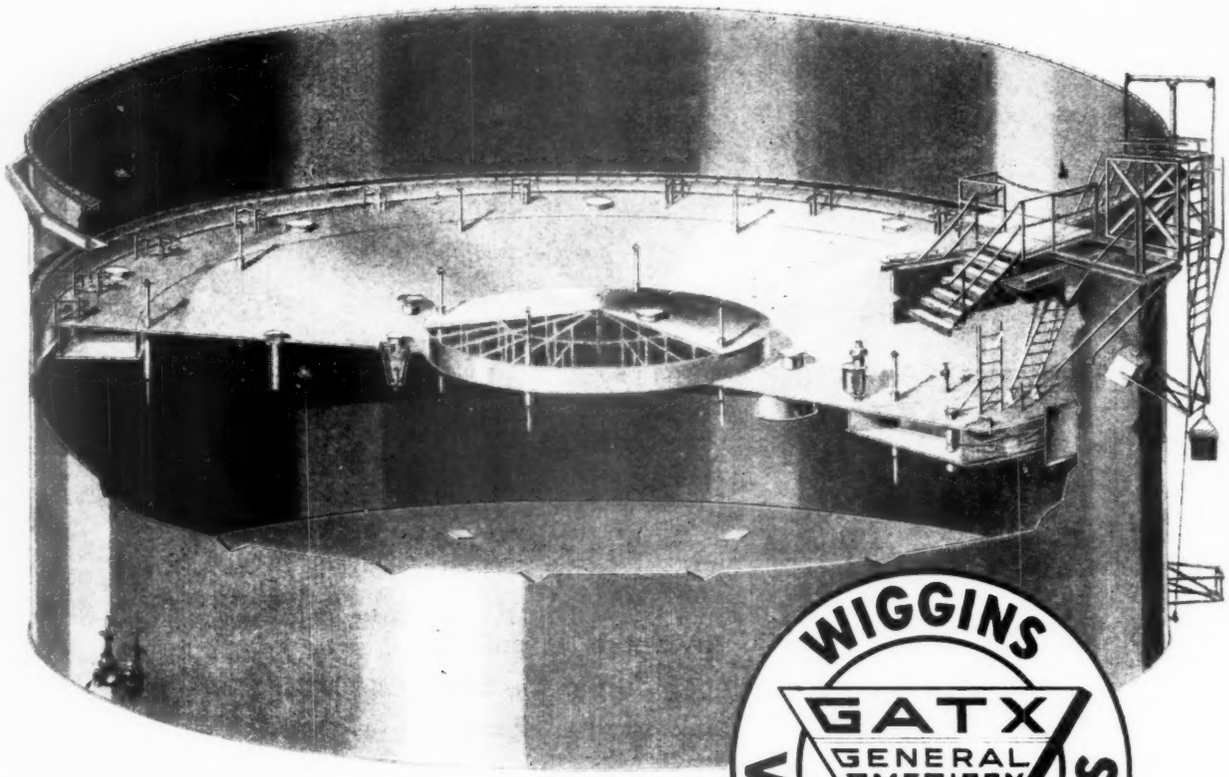
COMPRESSORS • DITCHERS • DOZERS
WELDERS • TRUCKS • TRACTORS

SMITH CONTRACTING COMPANY

ODESSA, TEXAS
MAIN BUSINESS OFFICE: FORT WORTH NATIONAL BANK BUILDING, FORT WORTH, TEXAS

LEADING THE FIELD

IN THE DESIGN OF CONSERVATIO



WIGGINS GATX GENERAL AMERICAN VAPOR SEALS

The Wiggins HIDEK FLOATING ROOF

- Improved Long-Lasting Seal
- Improved Drainage Features
- Improved Simplified Construction
- Improved Roomy Pontoons (patented)

One of these will reduce your evaporation problems

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Wyatt Metal & Boiler Works
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WESTERN STATES
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CANADA
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Protect your profit margin with economical, dependable LE ROI pumping engines . . . .

To oil men all over the country, Le Roi is the name that stands for a two-fisted engine . . . *specially designed* to take continuous, day-in and day-out punishment. Easy maintenance features and fuel economy give you lower operating cost. Ask your Le Roi distributor for details.

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MILWAUKEE

TURN THE PAGE

When they're "LE ROI'S"... drilling costs go down

When your rigs are "Le Roi-powered," you can depend on *profitable going* every foot of the way. Le Roi engines are made that way by a manufacturer specializing exclusively in heavy-duty engines — with particular emphasis on the power requirements of each of the three main divisions of the oil producing industry: drilling, pumping, and pipeline service. Ask your Le Roi distributor for the complete story or write for bulletins.

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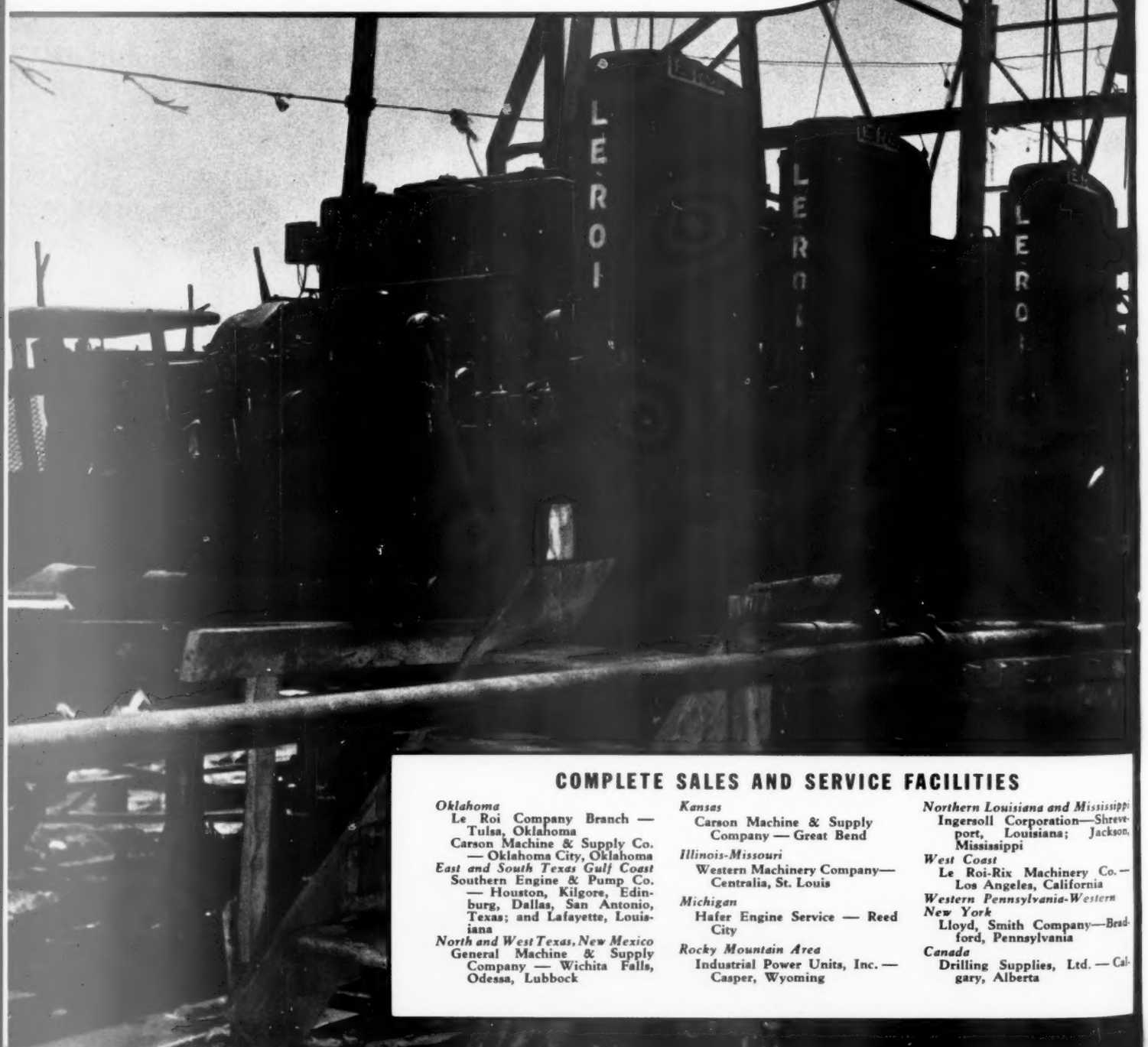

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General Machine & Supply Company — Wichita Falls, Odessa, Lubbock

Kansas
Carson Machine & Supply Company — Great Bend

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Western Machinery Company — Centralia, St. Louis

Michigan
Hafer Engine Service — Reed City

Rocky Mountain Area
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THESE TWO 55-GALLON DRUMS HAVE THE SAME CAPACITY

—but one with Tri-Sure Closures will drain 8 OUNCES MORE than the other

INSIDE OF HEAD OF 55-GALLON DRUM

The T-Square Test shows the flush fitting of the Tri-Sure Flange, which guarantees full drainage.

THE REASON being that the Tri-Sure Flanges engage *perfectly flush* with the inside of the drumhead. Tri-Sure assures *complete drainage* — prevention of waste — and delivery of full quantity.

Every time you make a shipment, for instance, of 10,000 55-gallon drums, this Tri-Sure characteristic saves over 650 gallons. This is only one reason why drum users all over the world have found that it always *pays* — in the prevention of *waste*, as well as leakage, seepage and tampering — to equip their drums with Tri-Sure Closures. Your customer receives exact gallonage, as filled — every time — when you specify "equipped with Tri-Sure Closures" on every drum order.

Tri-Sure
Reg. U. S. Pat. Off.
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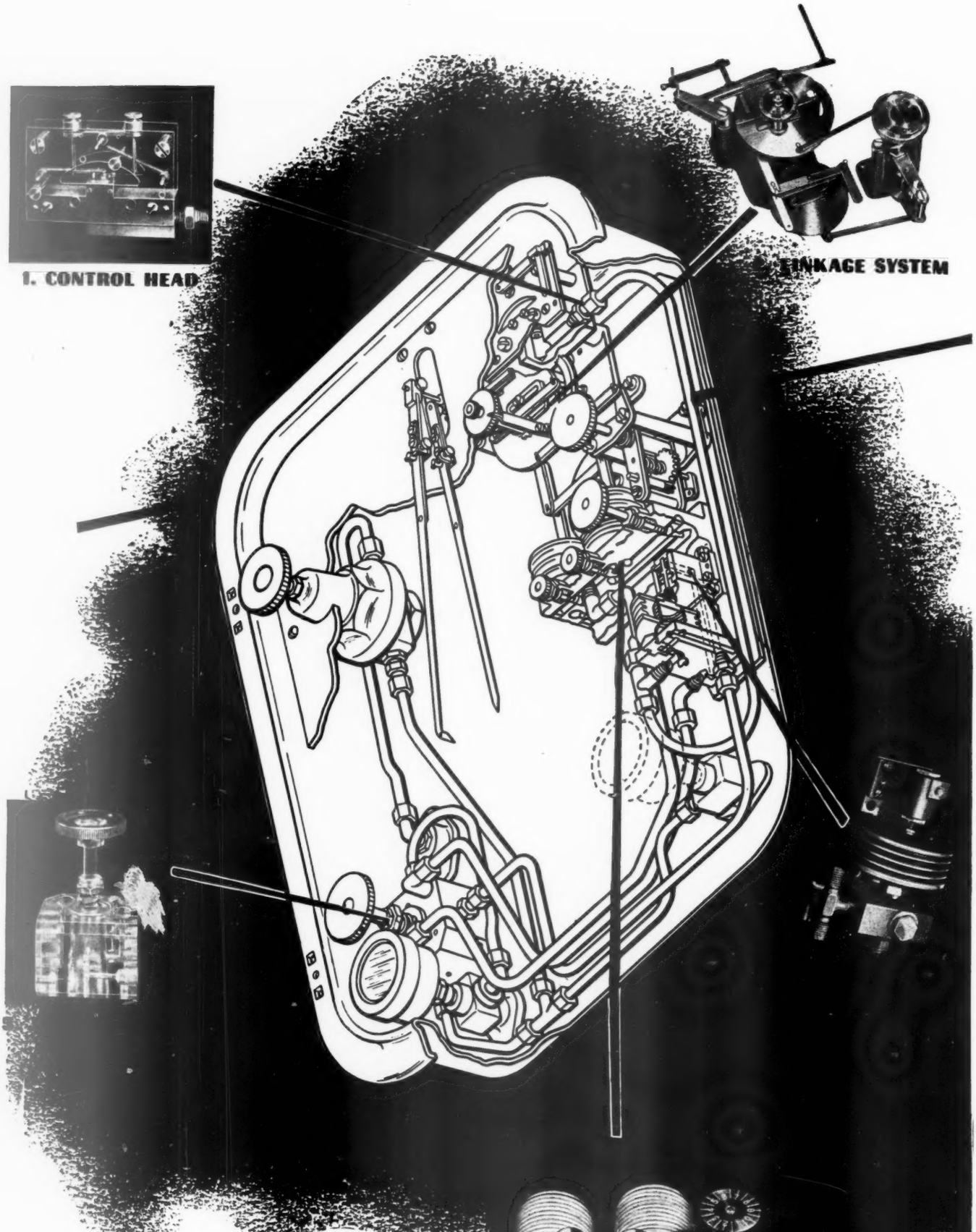
AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA


1. CONTROL HEAD
LINKAGE SYSTEM

DECADES OF EXPERIENCE

in

PROCESSING

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ENGINEERING

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for the

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E. B. **Badger** & SONS CO. Est. 1841

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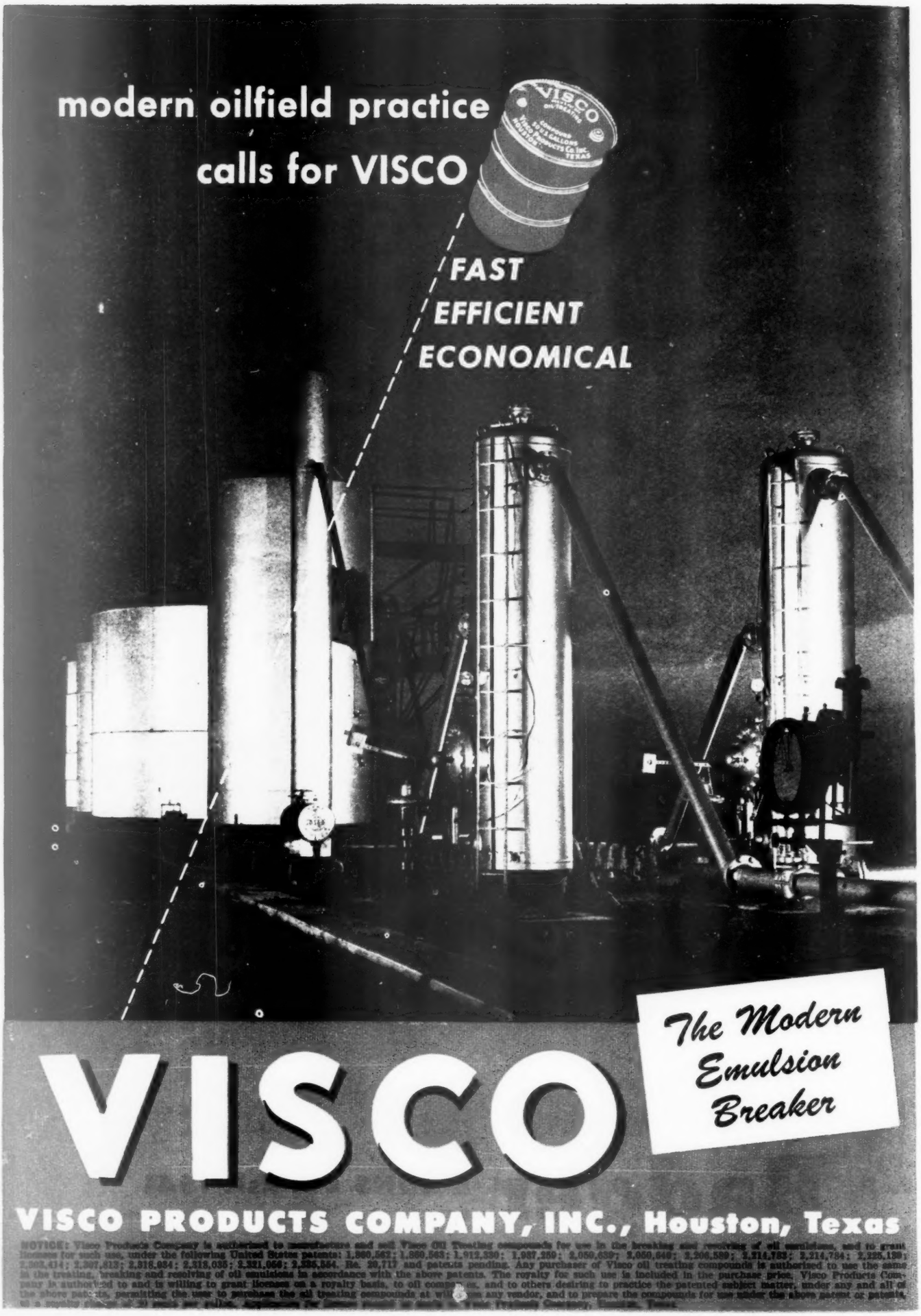
modern oilfield practice
calls for VISCO
VISCO
FAST
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The Modern
Emulsion
Breaker
VISCO
VISCO PRODUCTS COMPANY, INC., Houston, Texas
NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating compounds for use in the breaking and resolving of oil emulsions, and to grant licenses for such use, under the following United States patents: 1,860,562; 1,860,563; 1,912,330; 1,987,259; 2,050,639; 2,050,640; 2,206,589; 2,214,783; 2,214,784; 2,225,139; 2,307,474; 2,307,613; 2,316,084; 2,319,095; 2,321,066; 2,326,564. Re. 20,717 and patents pending. Any purchaser of Visco oil treating compounds is authorized to use the same in the treating, breaking and resolving of oil emulsions in accordance with the above patents. The royalty for such use is included in the purchase price. Visco Products Company is authorized to and is willing to grant licenses on a royalty basis, to oil companies, and to others desiring to practice the patented subject matter, under any and all of the above patents, permitting the user to purchase the oil treating compounds at will from any vendor, and to prepare the compounds for use under the above patent or patents, at a royalty charge of 20 cents per gallon. Applications for license should be made to Visco Products Company, Houston, Texas.

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IT'S A *Wilson*

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capable of drilling
to 20,000 feet!

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These are hectic days in the oil fields . . . drilling costs are jumping and competition, as you know, is always plenty stiff. A Wilson Rig helps to meet increased operating costs because of its greater all 'round performance . . . easy to operate . . . easy to repair . . . plenty of zip in coming out of the hole . . . built for rugged drilling. There's a Wilson model for every drilling requirement, from shallow wells to the unreached depth of 20,000 ft. On any drilling job look to Wilson for greatest drilling efficiency at lowest cost. Don't buy until you see the Wilson!

[WILSON RIGS AND WINCHES may be purchased from all recognized supply companies.]

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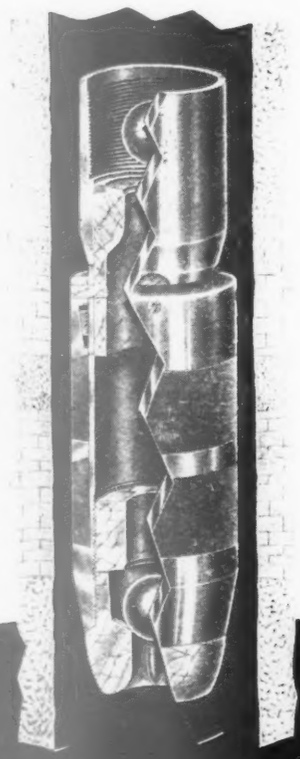
Cementrol*

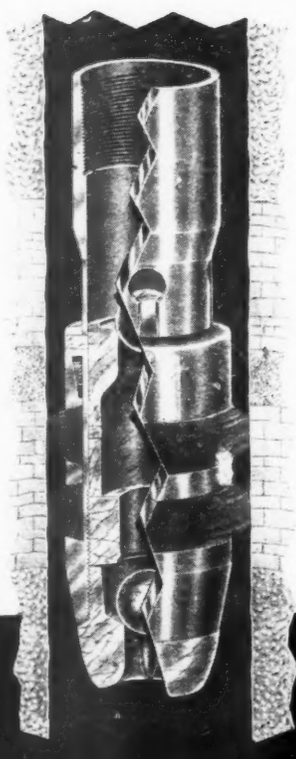


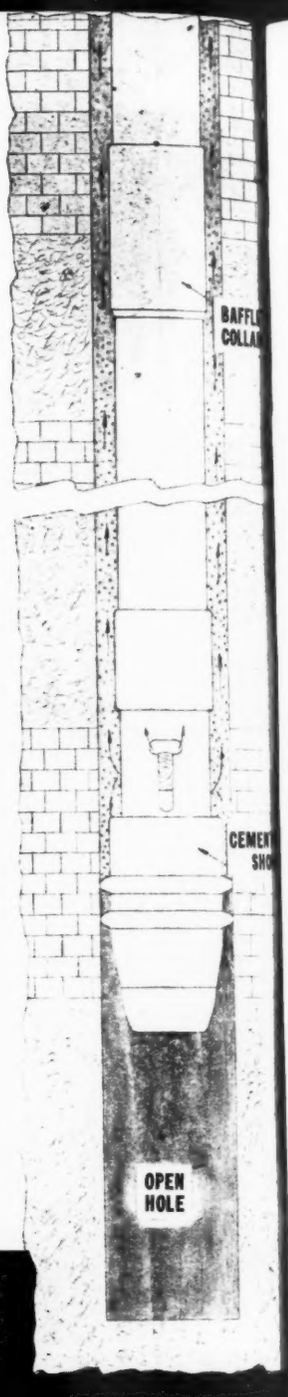
● Larkin Cementrol Equipment was designed for one purpose . . . to prevent damaging contamination caused by downward passage of cement into the open hole and producing formation below the casing seat. It is effectively fulfilling this purpose in wells from 1000 to 10,000 feet in depth, in all sections of the oil country.

Cementrol has so successfully filled this long-standing gap in cementing technique that it has become almost universally standard equipment where the need for such a tool exists.

If you are not yet familiar with Larkin's valuable cementing tool, please write for complete information. Better still, call your Larkin field man. He will gladly explain the operation of Cementrol and assist you in running it, free of charge.

Larkin Cementrol Equipment is available through your supply store.





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LARKIN

*REG. U. S. PAT. OFF.

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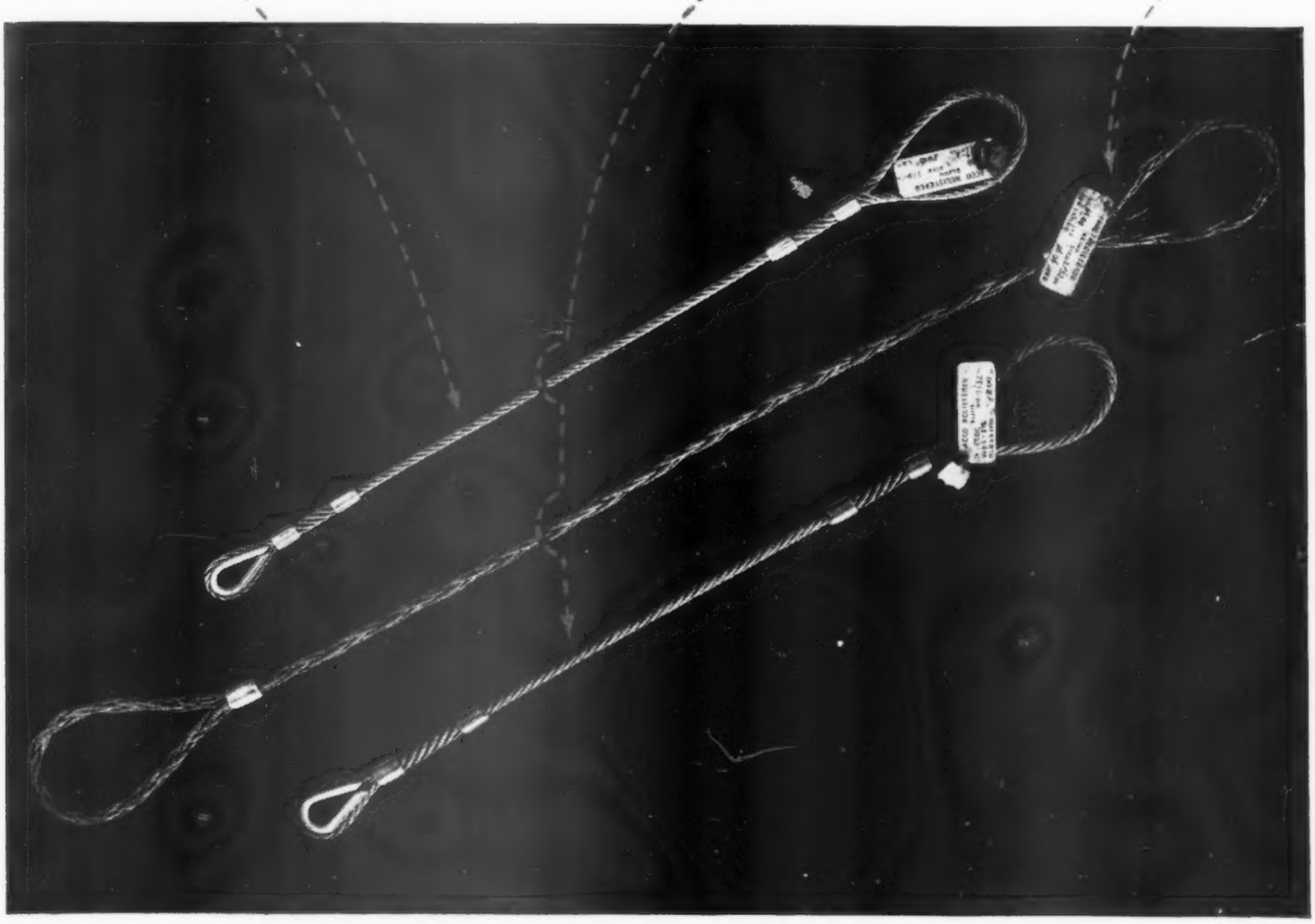
Strand-Laid? Cable-Laid? Braided?



American Cable has a wider range of sling types than any other manufacturer. Here you can get the exact type of sling best suited to your job. Whether the conventional strand-laid sling, the cable-laid sling, or braided slings made up in 4, 6 and 8 parts, American Cable engineers hold no brief except for the one that will do your job best. And in wire rope endings, too, American Cable takes the lead with the new, 100% efficient ACCO-LOC Safety Splice and the swaged U-LOC. More than this, you may have your American Cable slings proof-tested and registered for known strength and safety. Here again is another sling service that is exclusive with American Chain & Cable. You cannot buy a better sling than an ACCO-Registered sling — made of TRU-LAY Preformed Wire Rope of Improved Plow Steel.

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ROTO-WALL CLEANER

(for Removing Filter Cake and Centering Casing)

The Howco Roto-Wall Cleaner was designed to handle both the removal of filter cake from the well and the centering of casing, without restricting the flow area of the cement slurry.

The arrangement of the two rows of specially designed cleaning spikes and the staggering of the sections of cleaners used provide a "free flow" of fluid past the cleaner sections without creating an obstruction in the annular space of the well bore, which otherwise might cause a bridging action during the course of the cementing job.

For further information on the Howco Roto-Wall Cleaner, consult the nearest Halliburton representative, or write for bulletin.

HALLIBURTON OIL WELL CEMENTING CO.

DUNCAN, OKLAHOMA